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THESIS

MILITARY APPLICATIONS OF INTRANET TECHNOLOGY: FLEET NUMERICAL METEOROLOGY AND OCEANOGRAPHY CENTER

by
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September 1997

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Intranets are rapidly becoming a corporate internal information-sharing medium. Intranet technology is the same robust, proven, industry standard technology that is used on the Internet. The technical aspects of implementing the technology are simple. The organization and management aspects are significant and are key to its successful implementation. This internal use of Internet technology is easy, inexpensive, and has produced savings and benefits for corporate organizations.

This thesis reviews corporate and government intranets and examines the feasibility of implementing this technology and benefiting from it, in a military organization. Specific applicability of initranet technology was examined at Fleet Numerical Oceanographic and Meteorology Center, while maintaining the vision of its applicability to other military organizations. Fleet Numerical Oceanographic and Meteorology Center has the requisite technical and organizational infrastructure necessary to successfully implement intranet technology. The management and technical skill sets necessary to successfully implement this technology at any military command operating a computer network should be available, or easily trained. Fleet Numerical Oceanographic and Meteorology Center and the U.S. Military should establish the organizational plans and infrastructure to implement and exploit this empowering information sharing medium.

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MILITARY APPLICATIONS OF INTRANET TECHNOLOGY: FLEET NUMERICAL METEOROLGY AND OCEANOGRAPHY CENTER

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MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

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I. INTRODUCTION

A. PROBLEM DEFINITION

> ...the use of intranets in the enterprise will grow 110 percent this year. ...75 percent of all Fortune 1000 organizations will be running intranets by the end of 1998. ...more than 80 percent of Fortune 500 companies already have some kind of intranet in place. (Doolittle, 1997, p. 80)

Intranet development and use in the commercial sector have exploded within the past year. It is the result of redirecting many years of technological advances and breakthroughs in internet computing. Commercial and government enterprises are realizing cost savings and productivity gains by employing this inexpensive, easy-to-set up, platform-independent, universal client architecture. Perhaps one of the greatest gains brought about by intranets is the ease with which information is made universally available to a virtually unlimited base of users.

The United States Military is much larger than any single corporation. The military's ability to share, or not share, information in a seamless environment has been the subject of much debate in the past decade. The result has been numerous initiatives to establish an infrastructure using a common operating environment. Intranet technology has the potential to provide an architecture to easily share information both between and within organizations. This paper focuses on the ability to implement intranet technology at the military command level, including consideration to interface with enterprise level information sharing initiatives.

B. THE IMPORTANCE OF INTRANET TECHNOLOGY

> The rate at which a society's technology advances is determined by the relative level of its ability to process information. (Pilzer, 1990, p. 38)

During much of the cold war era, the military operated with almost unlimited funding. There was little incentive to analyze the business sense of expenditures. This often resulted in duplicative or proprietary development both between the military and commercial sectors and within the military itself. The post cold war era has brought with it a sharp decline in fiscal and other resources. It has become increasingly important to carefully analyze potential expenditures as well as undertake efforts to maximize productivity.

The application of information technology within the military should serve to promote and maximize the military's ability to process information. The need to leverage this technology is recognized at the highest levels of the military and is demonstrated throughout the conceptual template, Joint Vision 2010. At the same time, information technology has advanced at a tremendous rate during the past two decades. This makes choosing technology a difficult and risky task. Choosing immature technology, before it becomes an industry standard, can result in the need for substantial investment to make or keep an organization's information systems fully functional. Failing to reinvest in technology can result in the need for substantial reinvestment to maintain information systems functionality.

Intranet technology has become an industry standard. It is based on Internet web technology, which has continued to advance since its development in 1989. This

technology is proven on a daily basis as millions of government, commercial, and private sector individuals use the Internet to share and access information resources. The time to embrace this technology is while it is an industry standard, before technology advances to the point to where significant investment is required to bring older or obsolete systems up to current standards.

C. APPLICABILITY TO MILITARY COMMANDS

> ...major modernization efforts have shown that the introduction of newer, faster, cheaper technology is not a panacea for flawed management practices or poorly designed business processes. (Hoenig, 1996, p. 5)

The fact that many commercial enterprises have experienced cost savings or productivity gains does not mean that these benefits will translate to military commands or other commercial entities. Analyzing the feasibility and benefits of applying intranet technology within a military command or unit is paramount to deciding whether the military can benefit from adopting this technology.

To determine the applicability of intranet technology to the military computing environment, the authors studied its applicability to the Navy's Fleet Numerical Meteorology and Oceanographic Center, located in Monterey California. Fleet Numerical maintains a full spectrum of computing services ranging from desktop and notebook PCs to massively parallel supercomputers. The staff is comprised of military and civilian personnel, officers and enlisted, scientists, computer specialists, and administrative and support personnel. The center provides an ideal environment to

analyze an intranet's applicability to a broad spectrum of technology and personnel skill sets.

II. BACKGROUND

A. INTRANETS: WHAT THEY ARE AND WHY WE NEED THEM

An intranet is a small-scale version of the Internet inside an organization. A firewall is used to keep out intruders. Typically, an intranet is a network based on the Internet protocol: TCP/IP. It also uses World Wide Web (WWW or Web) tools such as Hypertext Markup Language (HTML), Common Gateway Interface (CGI) scripts, and Java programming language. All the functionality of the Internet can be made available on a private intranet inside a company, command, or organization.

1. Proliferation of Intranets

Almost every market research firm in the technology business considers intranets to be the standout growth area in networking. Creative Networks, Incorporated, of Palo Alto, California, predicts that the use of intranets in the enterprise will grow 110 percent this year. Zona Research Incorporated, based in Redwood City, California, expects corporate web server shipments destined for intranet use to far outstrip those destined for the Internet over the next three years. This will create an installed base of more than three million intranet servers and just more than half a million Internet servers by the end of 1999. According to the Gartner Group, 75 percent of all Fortune 1000 organizations will be running intranets by the end of 1998. Zona estimates that more than 80 percent of Fortune 500 companies already have some kind of intranet in place. Figure 2-1 illustrates

Global 2000 corporate intranet growth as of late 1996. (Doolittle, 1997, p. 80)

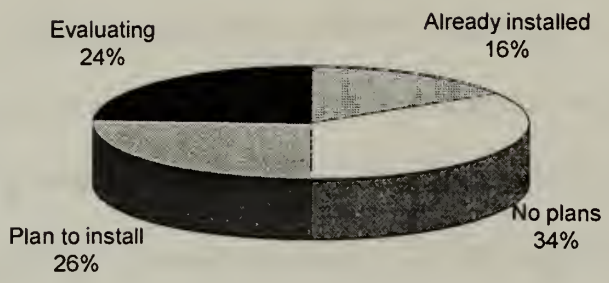


Figure 2 –1. Corporate intranets (Guengerich Graham, Miller, and McDonald, 1997, p. 12)

Driving the popularity of intranets is their inherent cross-platform support and low deployment cost. As organizations invest serious maintenance resources in the intranet model, it becomes increasingly important to make that m

odel work at the core of business operations. (Doolittle, 1997, p. 80)

The Gartner Group classifies intranet proliferation and development into three levels. Level I intranets consist of low-level implementations, static publishing, or simply moving content on-line. Level II intranet development centers around enabling core day-to-day applications for web use and using the intranet as a workgroup computing platform. Level III intranets will be characterized by a large base of web-enabled applications, a consolidation of dozens of Application Program Interfaces (API's) used in Level II, more secure web servers, and more powerful development tools.

Most companies spent 1996 testing intranet waters at Level I. Mainstream organizations are expected to develop Level II intranets in 1997 and 1998. By 1999, top organizations are expected to plateau at Level III. (Doolittle 1997, pp. 80-81)

2. Intranet Uses

Intranets are primarily used as information exchange mediums. They take advantage of web technology's ease of use to empower workers through the increased proliferation of information. Figure 2-2 gives a graphical breakdown of corporate intranet use. Here are a few examples of intranet uses:

- Electronic mail
- Directories
- Organization charts
- Memos
- Personnel manuals
- Benefits information
- Newsletters and publications
- Systems user documentation
- Training
- Newsgroups
- News extracts
- Job postings
- Sales reports
- Financial reports
- Customer information
- Quality statistics
- Vendor information
- Product information
- Marketing brochures, videos, presentations
- Product development information and drawings
- Supply and component catalogs
- Inventory information
- Network management
- Asset management

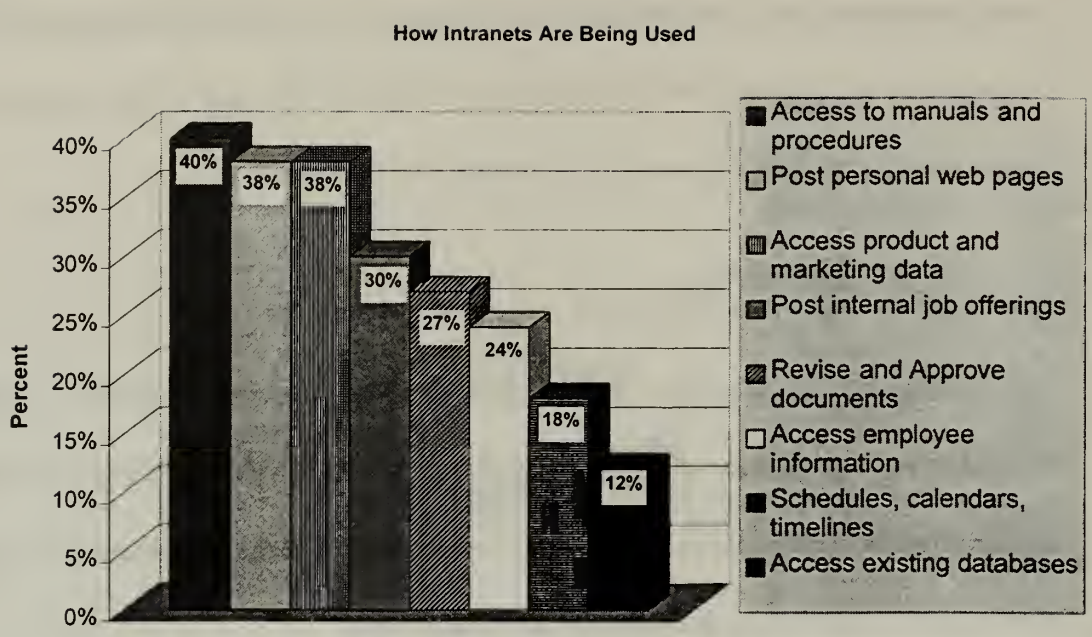


Figure 2 -2 How Intranets Are Being used (Dyson, 1997, p.15)

3. Intranet Components

An intranet operates using the client server model. There are two major components to every intranet: the Web Server (the server), and the Web Browser (the client).

a. Web Server

Web servers are the intranet's hub. They are computers containing the intranet's web pages and the Hypertext Transfer Protocol (HTTP). Web server software was originally written at the European Laboratory for Particle Physics (CERN) and the National Center for Supercomputing Applications (NCSA). It is readily available for most computing platforms.

b. Web Browsers

A Web browser's primary function is to be the Internet or intranet client, allowing users to navigate to different locations on the Internet or intranet and download Hypertext Markup Language documents and images to their client machines. Today, browsers also integrate other Internet-related functions including e-mail, newsgroups, chat, and File Transfer Protocol support, all using the same interface. (DePompa, 1997, p. 38)

c. Transmission Control Protocol/Internet Protocol (TCP/IP)

TCP/IP is a suite of related protocols developed by the Defense Department's Advanced Research Project Agency (ARPA; later DARPA) as part of its project on network interconnection began in 1969. TCP/IP is by far the most widely used protocol for interconnecting computers and is the protocol of the Internet. ARPA originally created TCP/IP to connect military networks, but provided the protocol standards to government agencies and universities free of charge. (Strebe, Perkins, and Chellis, 1997, p. 213)

The TCP/IP suite consists of the following:

- MIL-STD-1777 Internet Protocol (IP) - Provides a connectionless service to enable end systems to communicate across one or more networks. Does not assume the network is reliable.
- MIL-STD-1778 Transmission Control Protocol (TCP) - A reliable end-to-end data transfer service. Equivalent to Open Systems Interconnection (OSI) transport protocol.

- MIL-STD-1780 File Transfer Protocol (FTP) - A simple application for file transfer of ASCII, EDCDIC, and binary files.
- MIL-STD-1781 Simple Mail Transfer Protocol (SMTP) - A simple electronic mail facility
- MIL–STD-1782 TELNET - Provides a remote log-on facility for simple scroll-mode terminals. (Stallings and Van Slyke, 1994, p. 430)

Universities quickly adopted TCP/IP to interconnect their networks because it worked and was free. Many academicians collaborated to create higher level protocols for newsgroups, mail transfer, file transfer, printing, remote booting, and even document browsing. (Strebe et al., 1997, p. 213)

TCP/IP became the standard for inter-operating Unix computers, especially in the military and university environments. With the development of the Hypertext Transfer Protocol (HTTP) for sharing Hypertext Markup Language (HTML) documents freely on the Internet, the World Wide Web (WWW) was born and Internet use exploded into the private sector. (Strebe et al., 1997, p. 213)

TCP/IP has many advantages. It is the most flexible transport protocol. It is routable over wide, complex networks and provides more error correction than any other protocol. Every modern computer and operating system supports TCP/IP. Some other its advantages are:

- Broadband connectivity among all types of computers and servers
- Direct access to the Internet
- Strong support for routing
- Simple Network Management Protocol (SNMP) support
- Support for Dynamic Host Configuration Protocol (DHCP) to dynamically assign client IP addresses

- Support for most other Internet protocols such as Post Office Protocol (POP) and Hypertext Transfer Protocol (HTTP)
- Centralized TCP/IP domain assignment to allow internetworking between organizations

Disadvantages of TCP/IP include:

- Relatively difficult to administer correctly, although new tools like Dynamic Host Configuration Protocol make it a little easier
- Centralized TCP/IP domain assignment requires registration effort and cost
- Global expansion of the Internet has seriously limited the availability of unique domain numbers
- Difficult to set up
- Relatively high overhead to support seamless connectivity and routing
- Slower then Novell's IPX protocol and Microsoft's NetBEUI protocol

4. The Intranet Architecture

In designing an intranet for an organization, it is important to understand not only what an intranet is and how it differs from the Internet, but which intranet services will best serve the organization.

The Internet is a "network of networks." It connects networks throughout the world via the Internet Protocol (IP). An intranet is an internal, secure implementation of web technology as an organization's "network of networks." It employs IP-based technologies as well as non-IP-based technologies. Using IP-based technologies leads to platform independence, which is the ability to share the same information using different applications on different platforms. In short, by using IP-based protocols like Hypertext Markup Language (HTML), File Transfer Protocol (FTP), and others like Simple Mail Transfer Protocol (SMTP), documents and other items can easily be shared by computers

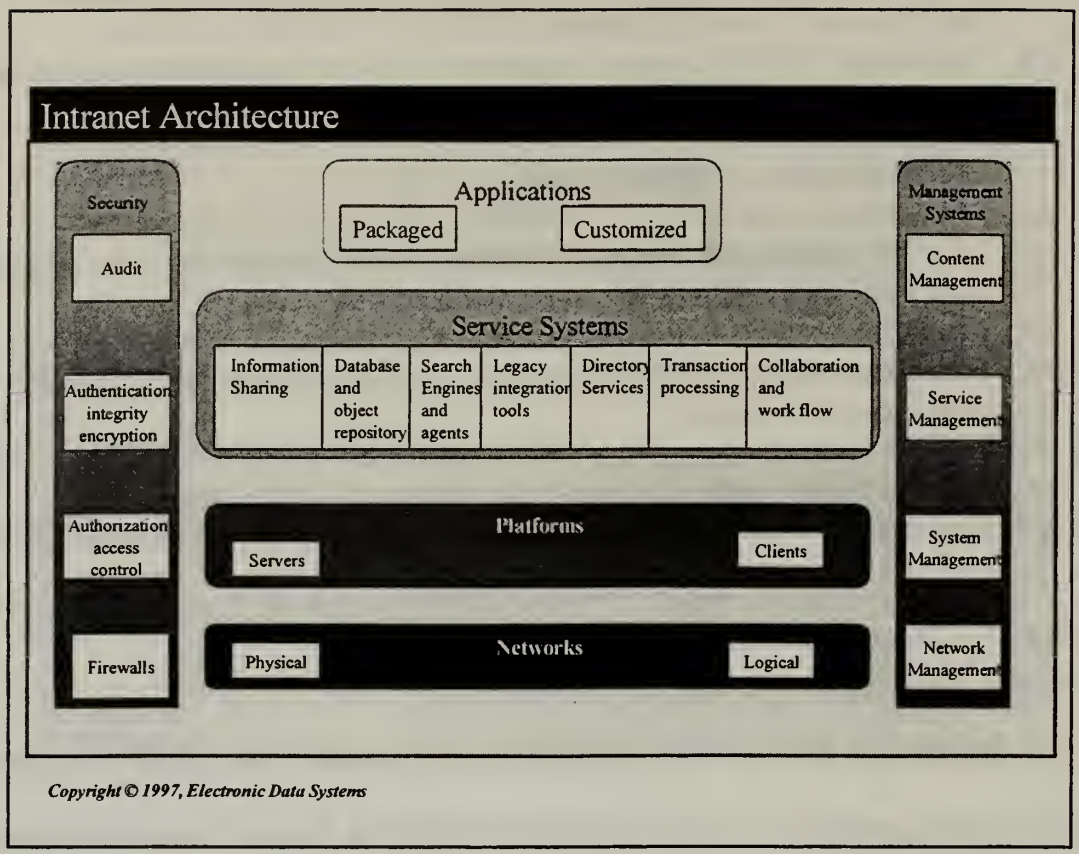


Figure 2-3: An Intranet Architecture (Brack, Reynolds, and Thomas, 1997)

operating under different operating systems.

Understanding which services will best serve an organization requires an understanding of intranet architecture. The intranet framework can be thought of as consisting of various layers and modules (see Figure 2-3). Requirements are passed down through the layers while services and capabilities are passed up through the layers. The network and platform layers constitute the intranet's infrastructure. The network layers consist of the physical hardware and services and logical components. The physical hardware includes cabling, fiber optics, hubs, routers, and switches. The logical

components include protocols for data transmission, error control, and routing. The platform layer comprises the client and server platforms. This layer addresses both hardware and software systems for the clients and servers. The application and system services layers provide the services and business function automation to the end user. The Management and Security towers address the need for secure and manageable delivery of services at all levels of the intranet. (Brack et al., 1997)

B. INTRANET BENEFITS

Intranets have become popular in organizations because they are relatively easy to set up and use. Intranet setup can be simplified into five steps: (1) get Transmission Control Protocol/ Internet Protocol (TCP/IP), (2) set up a web server, (3) get organized, (4) confront HTML, and (5) link web pages (Ayre, 1996, pp. 151-158). Once an intranet is set up, rich information with graphics, sound, and video, is only a mouse click away. Everyone can have access to the intranet regardless of the type of computer they are using. It is easy and inexpensive to add access to existing legacy data and applications. While other tools do a better job of many of the things that can be done with an intranet, nothing else brings it all together so well. (Hills, 1997, p. 28)

As with many information systems, intranet benefits are both tangible and intangible. Intranet benefits include:

- Fast and easy to implement
- Cheap to implement
- Easy to use
- Saves time

- Provides operational efficiency
- Saves money
- Based on open standards
- Connects and communicates among disparate platforms
- Puts users in control of their data
- Scalable
- Flexible
- Provides the richness of multimedia
- Leverages your infrastructure and applications investment (Hills, 1997, p. 29)
- Supports Structured Query Language (SQL) database queries or other interactive retrieval, display, and updating of database information
- Supports direct access to main frame legacy data
- Supports on-line forms, data entry, and interactive communications
- Supports automatic computer file downloading or transfer at the click of a button
- Saves disk storage by requiring only one copy of a file or image to exist organization-wide. (Bernard, 1996, pp. 60-61)
- Provides better communication
- Provides access to accurate information
- Captures and shares knowledge and expertise
- Provides better coordination and collaboration
- Provides for creativity and innovation
- Provides new business opportunities

(Hills, 1997, p. 29)

1. Advantages

Vital components to set up an intranet are readily available. Any computer running Unix, Windows 95, Windows NT, or Macintosh System 7 has Internet tools already built in, or easily added, including TCP/IP networking, web server software, and web client software. These components can help users do just about anything that is currently done on the Internet. But in many cases, these tools lie dormant because most businesses do not understand how to use them to enhance network communications

within their organization. (Bernard, 1996, p. 4)

Intranets can save printing and distribution costs. Companies that use web technology to distribute documents may experience momentous gains in productivity and incredible cost savings. Converting paper-based systems to web systems can save both labor and overhead costs within an organization. (Bernard, 1996, p. 25) For example, the Los Alamos National Laboratory reported that an estimated $500,000 in printing and distribution costs was saved during the first year of their intranet implementation (Wilkerson, 1996, p. 1). With an intranet, documents can be created with most word processors or desktop publishing tools, and as soon as the document is saved, it is immediately accessible to anyone in the company. (Bernard, 1996, p. 25)

This brings with it many advantages. First, everyone looking at the document sees the exact same version, and they see it without the need for a separate duplication and distribution system or process. Second, anyone referring to the document can easily cut and paste pertinent information into another document. Third, by adding hypertext links within the document, the document becomes an interactive tool that can link the reader to another document or other information source. Finally, the platform independent nature of HTML means that this new document is available to all users on the network, regardless of operating system (e.g., Unix, Windows, and Apple can access the same document).

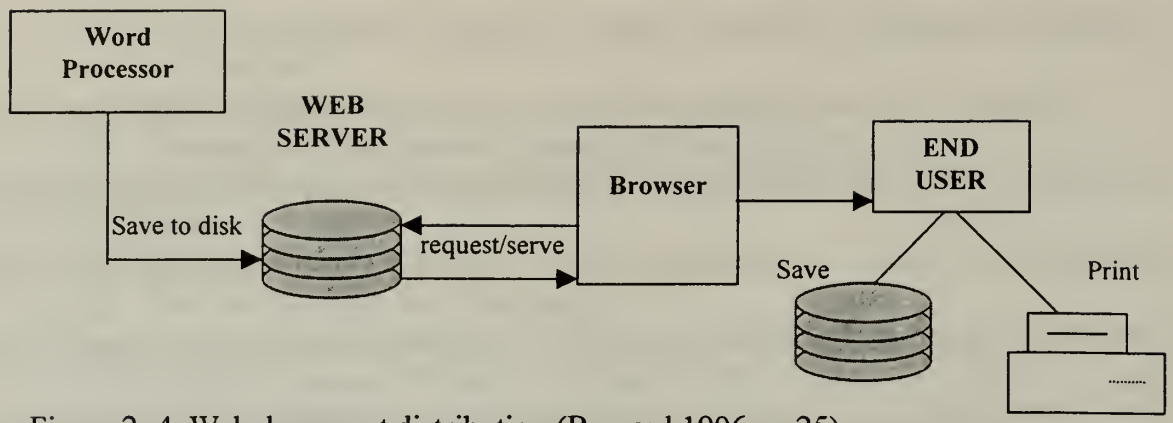


Figure 2- 4 Web document distribution (Bernard 1996, p. 25)

In order to make the document immediately accessible to other employees, instead of saving the document normally, it is saved using the "Save as" option, and instead of saving it on a diskette, it is saved on the web server (see Figure 2-4). Individual users do not have to be set up or configured to see the web server as a local drive mounted on their computer. The web browser can automatically find the information, no matter where it is located in the network. (Bernard, 1996, p. 25)

Intranets reduce paper disposal and help conserve resources. Beyond the cost savings of printing and publishing, paper reduction not only saves natural resources but also saves on costs associated with paper destruction (e.g., shredding) and disposal.

Intranets encourage an increase in an organizations' information sharing. Los Alamos National Laboratory found that their intranet made more data available to scientists at their desktops and gave regulators and administrators more timely access to information and greater control in choosing information they needed.

Little or no user training is required to use an intranet. Web networks offer a

transparent, intuitive interface to many. Web browsers reduce the need to teach communications processes, allowing Information Technology (IT) and Information Systems (IS) personnel to focus on teaching personnel how to use key applications (DePompa, 1997, p. 38).

Intranets are based on open system standards. By using an open system standard, organizations are able to implement this technology without being "held hostage" by a specific vendor. (Campbell, 1996, p. 13)

2. Concerns

a. Security from external entities.

Security from external entities is provided in one of two ways. The first technique is to operate the intranet physically isolated from any outside entity. The second technique is to install a firewall to isolate the intranet from external entities. This is especially important if the intranet will be connected to the Internet or other external networks.

b. Security from internal entities.

Unlike other client–server technologies, an intranet provides universal access across a network to anyone with a web browser, regardless of whether or not they are authorized to log into the computer where the server is located. That is not to say that a web site cannot be protected from unauthorized users; it can. It does mean that a web

site is open to all users by default, unless you specifically protect it. (Bernard, 1996, p. 66) As with some business and military information, not everyone is permitted to access all materials. At Los Alamos National Laboratory, users access legacy data and other transactions by logging in through their browser. A password authentication system tells the network who the user is and what rights they have before granting access. (Wilkerson, 1996)

C. THE VALUE OF INTRANETS

An intranet can be used to reduce costs and/or increase profits of existing business processes. It can become an integral part of redesigned processes, and it can support a organization's future. Each of these sources of value must be appraised in its own special way. (Hoffman, 1994) The success of any organization depends on the right people having the right information at the right time (Hoffman, 1994).

1. Intranets – An Industry Standard

> Technology determines what constitutes a need" (Pilzer, 1990). The relative rate at which...technology advances is determined by the relative level of [an organization's] ability to process information (Pilzer, 1990).

An industry standard may be defined as that the point where the combined effects of the risk of adopting a new technology and the risk of the technology becoming obsolete is the least. Figure 2-5 illustrates a curve that relates technological maturity, with the inherent risks of adopting new, less mature technologies, and the risk of

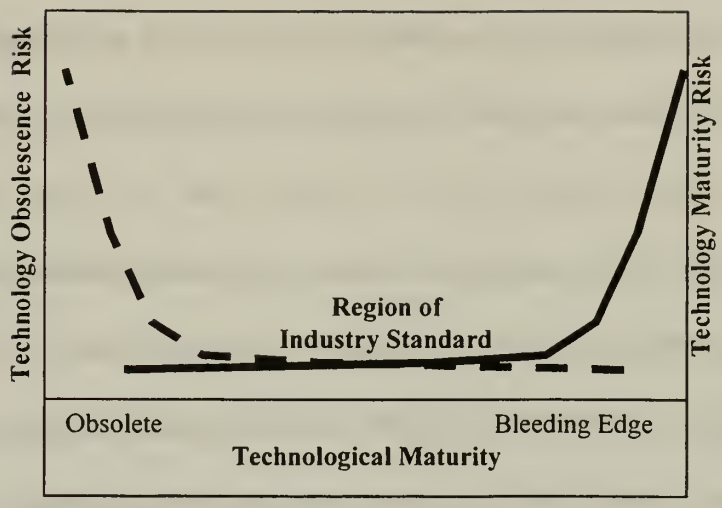


Figure 2-5 Technology Risk Curve

technological obsolescence. Many people recognize that risk is minimal when using accepted and proven industry standard technology. This is the marginal risk of change. Risks associated with using less mature technology (e.g., leading edge and bleeding edge technology) decreases as the maturity increases. Lagging behind the industry standard also increases risk. This is the marginal cost of reinvestment delay. Lagging behind industry standard increases the risk of obsolescence. The more obsolete an organization's systems, the more likely they are to encounter systems and software that they are unable to interface with or exploit. Additionally, as the organization's system becomes increasingly more obsolete, the greater the investment required to upgrade the system. Of course, the exact shape of these curves will depend on the technology considered, the development history, and trends.

Intranets are an outgrowth of Internet technology. The technology used in intranets is not new. It is only a different application of a widely used and tested technology. This technology is tested daily throughout the government, commercial and

private sectors as millions of users access the Internet. Web technology was introduced in 1989 by Tim Berners-Lee, at the European Laboratory for Particle Physics (CERN), thus creating the World Wide Web. The World Wide Web uses hypertext to link information. In 1993, Marc Andreessen created a program called *Mosaic* with the help of fellow students at the University of Illinois' National Center for Supercomputing Applications (NCSA). Mosaic was a graphical user interface that made the World Wide Web easy to use. (Hills 1996, pp. 5-6) Although technological advances in web browsers have made Mosaic obsolete, legacy documents prepared using the original Mosaic compatible hypertext markup language may be accessed using current browsers. Web technology has transcended many generations of technological advances and is the de facto standard for Internet publishing.

2. Commercial Business Practices

a. Information Sharing

It is becoming increasingly apparent that intranets offer the most innovative, cost-effective way of freeing organizational information from the inaccessibility of expensive-to-maintain legacy systems, which account for 95 percent of the installed worldwide information systems (Guengerich et al., 1997, p. 3). Intranets are important because of technological requirements imposed on businesses by the impetus for faster, better, and cheaper information. The need for information, particularly interconnected information, has become a major economic driving force. Thus, the

requirements for efficient communications, collaboration across space and time, and effective knowledge management are driving the development of intranets (Guengerich et al., 1997, p. 15).

Quick and effective communication is the key to survival in rapidly changing economic and business environments. Heightened competitive pressures obligate organizations to lower overhead costs and increase their agility in order to respond to ever-decreasing windows of opportunity (Guengerich et al., 1997, p. 16). Improving communication and access to information can increase the empowerment of employees, pushing the ability to make decisions to lower levels of the organization. In addition to communication, collaboration is essential to capitalizing on the abilities and talents resident in organizations. The need for collaboration in this new environment may be stated as follows:

> In society, academe, the sciences and business, the age of complexity confronts the era of specialization. The new reality is that it will take the collaborative efforts of people with different skills to create innovative solutions and innovative products (Guengerich et al., 1997, p. 17).

Collaborative tools create shared space. Web technologies have the potential to evoke the power of shared space, using a hybrid of text, image, sound, video, and computation that provides the framework for collaboration. (Guengerich et al., 1997, p. 18)

b. Return on Investment

Return on investment is essentially the financial rate of return that a company experiences for an investment. It is a measure of the return realized for every dollar spent. An independent research agency, International Data Corporation (IDC), conducted a return on investment study of many corporate intranets. Where possible, International Data Corporation calculated the actual impact of time saved on the profitability of the company. When this was not directly possible, International Data Corporation quantified the savings in time per employee and then corrected that amount to calculate increased productivity. In cases where the costs or savings were not directly quantifiable, International Data Corporation took steps to conservatively estimate values. For instance, in cases where corporations saved time, the International Data Corporation discounted the value of that time by a correction factor to account for the inefficient transfer of time between projects. (Campbell, 1996)

The preliminary results from International Data Corporation's intranet return on investment study found that the typical return on investment was well over 1000 percent, far higher than usually found with any technology investment. With payback periods ranging from six to twelve weeks, the cost of an intranet was quickly recovered, making the risk associated with an intranet project low. While these figures seem exceedingly high, they lend credence to two points. The first point is that investment costs for intranets are low. As a result, a nominal return will produce a large return on investment. Second, industry analysts are of the opinion that intranets are

capable of providing larger returns on investment when compared to other technology investments.

The greatest savings that International Data Corporation found was increased productivity. For every company profiled, having immediate access to information through an intranet made employees more productive. International Data Corporation found that using a browser as a universal client was a real benefit by reducing administration, lowering costs, and its ease-of-use. Additionally, many of the employees that International Data Corporation interviewed spoke about experiencing a true sense of openness. It is this openness and ease of information sharing that contributed most to the workers' increased productivity. (Campbell, 1996, pp. 1-3) Many corporations have realized significant returns on investment from their intranets. Some examples include:

- Lockheed-Martin 1500%
- Amdahl 2060%
- Silicon Graphics 1430%
- John Deere 200%
- Booz, Allen, and Hamilton 1390% (Langston, 1997)
- Cadence Design Systems, Inc. 1760%

Amdal's intranet strategy was to use it as a vehicle for information dissemination. The success of their intranet provides an example of the return on investment possible when an intranet is developed solely as an underlying infrastructure to be leveraged by groups requiring broad information dissemination. The high return on investment achieved by Amdahl is due to the value of the time saved through access to the wealth of information made available online. (Campbell, 1996, pp. 24-26)

Silicon Graphics is an excellent example of the returns which are possible when a company leverages an existing intranet for business-critical applications. A survey of Silicon Graphics employees allowed International Data Corporation to calculate the average savings in time to create purchase requisitions and the average time saved during the review and approval process. The total time was then multiplied by the corrected, average, fully loaded cost of a Silicon Graphics employee to calculate the value of the savings.

To achieve their return on investment, Silicon Graphics developed a web-based purchasing application and fully integrated it with the company's suppliers and legacy applications. Silicon Graphics experienced the greatest benefits in three areas. First, the number of purchase orders manually processed each year dropped dramatically. Second, by reducing the number of outside vendors and accurately tracking the volume of purchases, Silicon Graphics was able to negotiate discounts in addition to the company's already low purchase price. Third, the automated routing process that drops shipments directly at the employee's desk reduced the time an employee spent creating and tracking a purchase requisition.

Booz, Allen, and Hamilton's return on investment is due largely to the time saved by using their intranet instead of previous informal methods of information transfer. The intranet allowed both newly hired and long-time consultants to share information and gather data to support decision making in a quick, cost-effective, and efficient manner. To calculate Booz, Allen, and Hamilton's return on investment,

International Data Corporation surveyed the amount of actual time saved by using the intranet to share and retrieve information. The average time was then reduced by a correction factor to account for inefficient transfer of time calculations. To place a value on employees' time, International Data Corporation used Booz, Allen and Hamilton's composite billing rate. (Campbell, 1996, p. 16)

Cadence Design, Incorporated, reported that the greatest impact of their intranet was due to shortening the learning time for new sales representatives. Reductions in the time to become a fully capable sales representative ranged from two to four months. With 40 new representatives hired in the first year and 40 planned for each of the next two years, reducing the ramp-up time for new sales representatives has a substantial impact on additional profits. To calculate the value of Cadence's intranet, International Data Corporation focused on the initial profit potential of new sales representatives rather than the time saved by existing sales representatives using new processes. In order to achieve their return on investment, Cadence identified sales processes that used a framework for electronic delivery and support, reengineered the process to match the business need and created an appropriate supporting infrastructure. (Campbell, 1996, p. 6)

Intranet costs can be broken down into two categories: hardware/software costs and people costs. International Data Corporation found that hardware and software costs were far less significant than the cost of personnel. For example, BSG Corporation's preliminary budget for a very basic intranet platform to accommodate a

company of 5,000 users across multiple locations and multiple platforms is given below:

SW/HW Costs:	Quantity	Price per Unit	Cost
Development			$7,000
Web/database server	1	$25,000	
CGI developer workstation	1	$10,000	
HTML developer workstation	1	$8,000	
Developer admin workstation	1	$3,000	
Deployment			
Server software	1	$7,000	
Server hardware	1	$9,000	$9,000
Applications firewall	1	$5,000	$19,000
Additional hard disk space	4	$25,000	$1,000
Back-up drive and media	1	$2,000	$2,000
Communications router	1		$1,500
Network services (3rd party)	Quality of service	~$1000.00/mo	
Web clients—software only	up to 5000	~$40 /client	$10,000
Admin clients—software only	up to several hundred	~$1000/client	$18,000
Totals (not including labor costs for deployment)			$67,500

BSG Web development system budget (Guengerich et al., 1997, p. 26)

Table 2-1 BSG Web Development System Budget (Guengerich et al., 1997, p. 26)

Part of an intranet's return on investment is realized as cost savings. For example, many companies have found that browser ease-of-use has translated to low cost training. Intranets significantly reduce the typical rollout plans for outside trainers and time lost in training classes as a necessary part of a rollout plan. This is particularly applicable when deploying training programs to remote workers, or to high-level management--typical areas where training costs can be expensive. (Campbell, 1996, p. 2)

On the savings side of the return on investment equation, International Data Corporation found that intranets provided quantifiable benefits in areas such as reducing the use of paper or supporting ISO 9000 initiatives. However, the greatest area of savings is in increased productivity. For every company profiled by International Data Corporation, having immediate access to information through the intranet made employees more productive. (Campbell, 1996, p. 3)

c. Hackman-Oldman and Intranet Return on Investment

The Hackman-Oldman Job Characteristics Model may provide a means to explain increased worker productivity when using intranets. In the Hackman-Oldman model, three critical psychological states must be achieved to produce a worker's high internal motivation. The three psychological states are: experienced meaningfulness of the work, experienced responsibility for the outcome of the work, and knowledge of the actual results of the work. These psychological states are internal to a person and cannot be used to directly explain how intranets can improve worker productivity.

Research suggests that five job characteristics may be useful in providing reasonably objective, measurable, and changeable properties of the work itself to foster these psychological states (Hackman and Lawler, 1971; Hackman and Oldham, 1976; Turner and Lawrence, 1965). The Hackman-Oldham model relates skill variety, task identity, and task significance as contributors "to experienced meaningfulness of the work". It relates autonomy as a contributor to "experience responsibility for outcomes" of the work. And it relates job feedback as a contributor to "knowledge of the actual

results of work activities". (Hackman and Oldham, 1980) Figure 2-6 graphically demonstrates the Hackman-Oldham Job Design Model. An intranet uses many of these job characteristics and thus improves worker productivity.

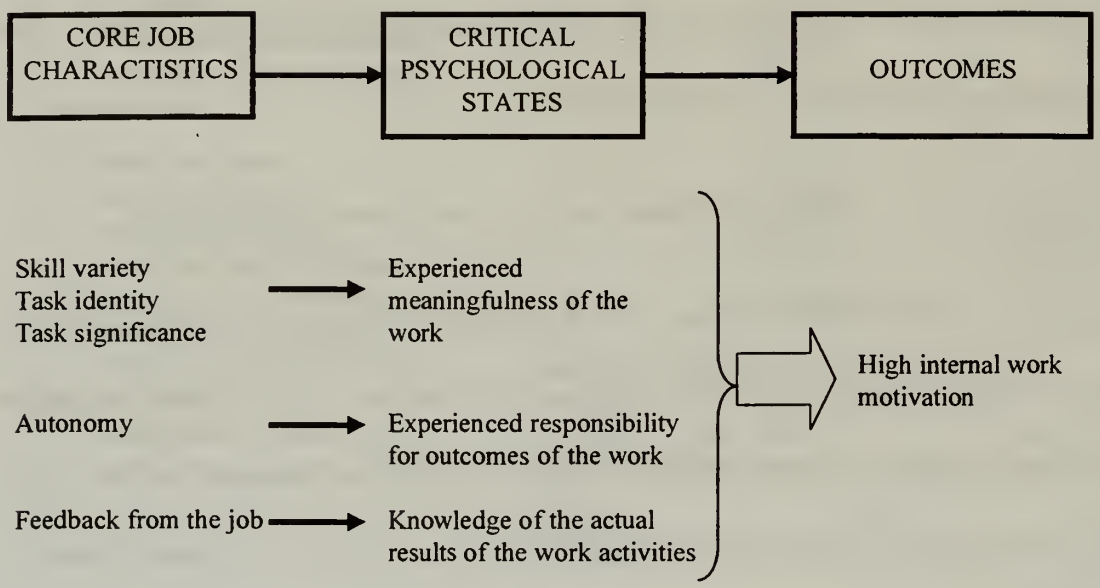


Figure 2-6 The Hackman-Oldham Job Characteristics Model (Hackman, 1980, p. 90)

An intranet contributes to "experienced meaningfulness of the work" through improved skill variety, task identity, and task significance. Hackman and Oldman found that by increasing the variety of different tasks in carrying our work, or using a number of skills and talents positively contributed to "experienced meaningfulness of the work". An intranet increases the application of individual skills and talents by applying web technology. A browser's ease-of-use and widespread use in accessing an intranet or the Internet makes it an easy addition to an employee's skill set, if it is not included already. The ease of publishing HTML documents, with current

office suite software, is another easy addition to employee skill sets. Thus, implementing an intranet increases employee skill variety at work. The ease of web publishing contributes to both task identity and task significance. Task identity is achieved by allowing employees to produce a "whole and identifiable" piece of work. With an intranet, it is easy for an employee to produce a "whole and identifiable" piece of work whether it be a specific web page or an entire web site (a organized collection of web documents linked together with hypertext). And, an intranet's ability to immediately make this product and its information available to employees-at-large, coupled with the employee empowerment that normally accompanies the information, increases the potential that an individual's job may have substantial impact on the lives of other workers. (Hackman and Oldham, 1980)

Many of the companies that posted substantial returns on investment also allowed employees to create and post web pages of their own. This freedom, independence, and discretion for the individual to carry out his/her tasks increases an individual's tendency to feel more personally responsibility for success and failures that occur on the job. This also develops employees that are more willing to be personally accountable for the outcome of their work. (Hackman and Oldham, 1980)

Finally, the ease of publishing on an intranet can positively contribute to an employee's job feedback. Job feedback may be broken down into two forms of feedback: feedback from the job itself, and feedback from external agents (supervisors and co-workers). For a job to provide job feedback, doing the job itself must provide the

person with information about his or her work performance (e.g., the job provides clues about how well the person in is doing). When part of a person's job is to publish to the organization's intranet, the person can immediately receive feedback about that aspect of their job performance. Individuals who publish on an intranet can immediately check their document or web site by using their web browser and seeing the quality of their work. The web page(s) that the employee examines are exactly the same pages that will be examined by supervisors and co-workers. Additionally, publishing on an intranet makes the document immediately available to a wide range of employees, significantly increasing the document's exposure and the likelihood that the employee will receive feedback from other supervisors and co-workers. These external agents provide employees with direct and clear information about the effectiveness of his or her performance. The greater the proportion of intranet publishing that a person's job involves, the greater the feedback through these mechanisms.

3. Military Intranet Applicability

> This era will be one of accelerating technological change. Critical advances will have enormous impact on all military forces. Successful adaptation of new and improved technologies may provide great increases in specific capabilities. Conversely, failure to understand and adapt could lead today's militaries into premature obsolescence and greatly increase the risks that such forces will be incapable of effective operations against forces with high technology. (Chariman of the Joint Chiefs of Staff, 1996, p. 11)

The information and personal computer revolution have made the personal computer an essential tool to almost every desktop in the government, military, and

corporate America. At first, the personal computer was a tool to improve worker productivity using word processors, spread sheet programs, database programs, and other software tools. The widespread interconnection of computers through local area networks (LANs), wide area networks (WANs), and the Internet have made the personal computer the primary platform for information sharing of the 1990s.

The virtually limitless cold war defense budget drove the military to operate with little incentive to apply business-like spending strategies and created an environment that fostered the development of stove piped systems. These systems were intentionally designed to achieve greater systems specialization, in an effort to acquire greater appropriations, but this resulted in the byproduct of creating systems that were often not usable by other services. The end result was an exceptionally capable, but non-interoperable, military force that could not communicate and share information with their disparate communications and information systems.

The post cold war military reduction, and military engagements in Grenada, Panama, and the middle east, have drawn attention to the military services' stovepiped systems and inability to easily share information. A graphic example of this occurred during the military engagement in Grenada when an Army unit, pinned down by hostile fire, needed to communicate with C-130 gunships for support. The Army unit could not communicate with them using their existing military communications equipment. The solution was to use one of the soldiers' commercial telephone calling card to call their headquarters unit back in the United States, and have their headquarters unit relay

necessary information to the C-130 gunship via its operational chain of command. (Anno and Einspahr, 1988, p. 36)

The need to seamlessly communicate and exchange information between and among the military services has provided the impetus to legislate, design, and engineer systems that can operate in a "joint" military environment. Additionally, the post cold war reduction in defense spending has forced military leaders at all levels to adopt business-like spending strategies.

Military leaders at the highest levels have identified information technology as a key leveraging agent in developing and applying new strategic concepts for the 21st century (Chairman of the Joint Chief of Staff, 1996, p.1).

As the military embraces the information and personal computer revolution, it is also wrestling with the need to replace aging legacy communications and information systems as part of Year 2000 initiatives. At the same time, military units are expanding their computer inter-connectivity and information sharing capabilities. The expansion of information sharing capabilities is developing from the top-down as well as the bottom-up. This growth must be properly managed and guided through a standardized infrastructure to insure that information sharing will be capable between and among military units.

During this growth and transition, military commands and units are analyzing their information technology investments in attempts to maximize the returns on their investments. Additionally, the military has paralleled the commercial sector adoption of

the employee empowerment philosophies of W. Edwards Deming and Joseph M. Juran. The Internet/intranet concept of open information sharing complements employee empowerment philosophies.

The post cold war military developments coupled with the information and personal computer revolution have created an environment in which intranets can potentially serve as a solution.

a. Naval Applications of Intranet Technology

There are several initiatives involving intranets and extranets within the Navy. Intranets are internal implementation of internet technology. Extranets are created by adding an additional intranet layer and allowing outside entities access to this external proprietary media. This creates a "virtual" intranet outside of the organization but separated from the general public.

Naval intranets are an outgrowth of the Enterprise Networks of a few years ago. An Enterprise Network is a dedicated network and services used solely within a major command or system command (SYSCOM). This initiative began in early 1994 when the Defense Information Systems Agency (DISA) began capitalizing both service owned internets and dedicated multiplexed networks. The networks capitalized were the Navy's Network (NAVNET), the Air Force's Network (AFIN), the Army's Network (ARNET), the Defense Logistics Agency's Network (DLANET), and the Defense Data Network (DDN). These networks were combined to make up the new Defense Information Service Network (DISN), once referred to in newspapers as the "Mother of

all Networks" (Glenn, 1997). The transition resulted in high bandwidth trunks (T-1 1.544 Mbps to T-3 44.736 Mbps) being multiplexed in order to provide voice, video, and data circuits that were dedicated by application. This initiative was undertaken to save money by replacing the many contracts used for each circuit leaving an installation.

The Navy's Enterprise Network began when one of the Navy's systems commands, Navy Air (NAVAIR), procured links that provided a dedicated network to field activities (NAVWAN). These links used the Defense Information Systems Agency's multiplexed network but used internet routers to create an Enterprise Internet, or by the currently accepted description, intranet. (Glenn, 1997)

The advent of Defense Information Systems Agency controls forced smaller commands to use a less expensive solution. The cost of routers and dedicated links was too high. The solution developed was to procure ports on the Defense Information Systems Agency's unclassified but sensitive Internet Protocol Router Network (NIPRNET). The NIPRNET is supposed to be a transition topology to the Defense Information Services Network-Internet Protocol (DISN-IP) network as funds are programmed for future implementation. In this scenario the command links up their field commands to the NIPRNET and installs filters, firewalls and business practices that allow the commands to emulate an intranet, sometimes referred to as a "virtual" intranet. The Navy's Public Works Centers, Supply Centers, and other activities have either implemented or moving toward implementing this concept. (Glenn, 1997)

Naval applications of intranet technology are also implemented on a smaller scale within major commands. The headquarters of Commander in Chief, U.S. Pacific Fleet, maintains two intranets behind their firewall. The intranets are intended for internal staff use only. One of the intranets operates on the command's unclassified network, while the other operates on the command's classified network. (Kooker, 1997)

The Navy's implementation of extranet technology begins with either an intranet or a "virtual" intranet and adds secure servers or web services to allow those entities that are not within the command to support the business plans. An example of this is the F18 Aircraft Program Management Office which uses a service out of Pensacola. The service uses a certificate web server when exchanging information with the office's contractors, the Navy Inventory Control Point, the Defense Logistics Agency, the Naval Depots, and the Fleet. (Glenn, 1997) Server authentication by using certificates, a trusted authentication device exchanged between clients and servers, assures the client and server that they are communication with authorized entities (Guengerich et al., 1997, p. 167).

b. DoN CIO Navy-wide Intranet Initiative

In a briefing to Naval Postgraduate School faculty and students, the Department of the Navy Chief Information Officer (DoN CIO), Dr. Marvin Langston, articulated his vision of a Navy-wide intranet. This intranet will connect all Naval suppliers and users of information. At the heart of Dr. Langston's initiative are lessons learned from industry in capitalizing on Metcalf's Law. Metcalf's Law essentially

establishes that the value of a network increases as the square of the number of nodes.

$$\textbf{Value} = k(\textbf{Nodes})^2$$

The industry application of Metcalf's Law establishes that a Revolution in Business Affairs (RBA) is a function of intranet capability and process change raised to the creativity power.

$$\textbf{RBA} = \textbf{f(intranet capability x process change)}^{\textbf{creativity}}$$

Organizations that have realized a substantial return on investment have done so after achieving a critical mass of network nodes. As a result, there is a period of investment required to achieve this critical mass. Returns may or may not be experienced during this period. Those organizations that reached a critical mass of nodes subsequently achieved a revolution in business affairs through information sharing on their network. The Department of Navy is currently in the investment stage and has not yet achieved a critical mass. Dr. Langston believes that the Department of the Navy is capable of achieving a critical mass and begin realizing intranet returns on investment within the next year. (Langston, 1997)

c. IT-21

Information superiority is the foundation of Joint Vision 2010 Battlefield Dominance, as well as the warfighting vision for each service. Network warfare, robust infrastructure, and information dissemination to dispersed forces are key elements in achieving information superiority. IT-21, is the vision of Admiral Archie Clemins, Commander in Chief, U.S. Pacific Fleet, is a fleet driven reprioritization of Command,

Control, Communications, and Intelligence (C4I) programs of record to accelerate the transition to a PC based tactical and tactical support warfighting network. The inactivation of the current Department of Defense messaging system (AUTODIN) by December 1999, with no planned Navy infrastructure replacement, mandates the rapid implementation of this warfighting network. (Commander in Chief, U. S. Pacific Fleet, 1997) Admiral Clemins' IT-21 vision includes using browser technology, with continuous TCP/IP connections and multi-level security, in a client-server environment. IT-21 will create a system built to industry standards that uses commercial off-the-shelf technology, is devoid of stovepipes, allows the convergence of tactical and non-tactical uses, moves databases ashore, and allows afloat users to pull only the information they need in a way that is seamless to the user (Clemins, 1997).

IT-21 grew out of the Global Network Initiative (GNI), a project that Admiral Clemins kicked off during his tour as Commander Seventh Fleet, just prior to his taking command as Commander in Chief, U.S. Pacific Fleet. The Global Network Initiative equipped the Seventh Fleet command ship, USS Blue Ridge, as well as the aircraft carrier, USS Independence, with prototype IT-21 systems that harnessed the power of PCs interconnected via high-speed backbones to Command and Control (C2) systems. In 1996, Global Network Initiative was proven when the USS Independence "showed the flag" in the Taiwan Strait as China test-fired missiles near the island of Taiwan. Admiral Clemins called the use of Global Network Initiative during that period "the first major evolution of command and control by electronic mail and browsers." The

initial version of IT-21 was successfully tested in early 1997 during exercise Tandem Thrust off the Australian coast. (Brewin 1997, p. 30)

Admiral Clemins wants to deploy the IT-21 architecture to the entire Navy for very solid reasons. Clemins said:

> We can't do this one ship at a time. We have to do it by entire battle groups, and we have to do it ashore as well as afloat. We have to do it in the Third Fleet, the Seventh Fleet, and the Fifth Fleet and the Atlantic Fleet. It does not do me any good if I can't communicate with the Atlantic Fleet. (Brewin, 1997, p. 30)

A fundamental precept of IT-21 is that commercial Network Operating Systems (NOS) and electronic mail products have achieved functional parity. The Atlantic and Pacific fleets cannot continue to support a multitude of diverse operating systems and e-mail products with their own training, operational procedures, and troubleshooting requirements. The Department of Defense Joint Technical Architecture (JTA) and Defense Information Infrastructure Common Operating Environment (DII COE) provide the Department of Defense with the Automated Information Systems (AIS) guidance required to take the Navy into the 21st century. This convergence of solutions, problems, and guidance provides the impetus to establish minimum Navy Automated Information System standards. Implementing the IT-21 policy requires replacing all non-standard network operating systems and e-mail products no later than December 1999.

Under IT-21, Windows NT Server 4.0 is designated the standard fleet network operating system. Windows NT 5.0 is the designated follow-on system. Windows NT Server 4.0 is Defense Information Infrastructure Common Operating

Environment compliant. Microsoft Exchange is designated as the standard e-mail solution for both fleets to ensure that an interoperable and secure messaging system is operational prior to the December 1999 AUTODIN inactivation. Microsoft Office 97 is designated as the standard fleet office suite software. This environment cannot be optimized without 32-bit operating systems, high-resolution displays, and mass storage. IT-21 assumes that Asynchronous Transfer Mode (ATM) backbone local area networks (LANs) with at least 100 MBS (TCP/IP) to the desktop PC are to be installed on all shipboard local area networks and fleet headquarters. IT-21 recommends that shore activities that support tactical operations install IT-21 equipment. This will allow the transition to ATM-to-the-desktop PC when Asynchronous Transfer Mode (ATM) technology matures. Both the Pacific and Atlantic Fleet Commanders are requiring that programs installing information systems (NEWNET, SMARTLINK, SMARTBASE, TELEMEDICINE, etc.) must install components in fleet activities that meet IT-21 standards and provide inter-operability throughout the warfighting network.

The IT-21 standards below represent early 1997 front-end market technology, are dynamic in nature, and will continue to be closely linked to commercial trends. The standards listed below are the minimum fleet standards and will be updated periodically by the Pacific and Atlantic Fleet Commanders. IT-21 standards are detailed in Appendix A.

Some federal users still prefer time-honored Unix over the newer Windows NT. Despite this fact, the Defense Information Systems Agency is putting Windows NT

through certification testing for use as the standard network operating system for electronic mail throughout the Defense Department. Additionally, in recent months, officials at individual Department of Defense services have said they plan to migrate many desktop users from Unix to Windows NT because of Window NT's reduced cost and easier user and administrative training associated with the PC workstation platform. (Gerber 1997, p. 32)

Unix still has some significant advantages over Windows NT in terms of reliability and performance, but the total cost of owning Windows NT is less than Unix. Today Windows NT only supports a maximum of 256MB of RAM, while Unix can handle 4GB. Windows NT only supports four-way symmetric multi-processing. Unix supports Wolfpack clustering technology; Windows NT will not have this capability until a new add-on package is made available by Microsoft. Clustering is a group of systems that work together as one. When one system fails, clustering technology reroutes the work from the failed system to the functioning ones, thus providing high availability. If there is work overload, the clustering technology allows other servers to be added, thereby providing scalability. (Gerber 1997, p. 34)

d. Defense Information Infrastructure Common Operating Environment

The Department of the Navy Chief Information Officer's Navy-wide intranet will connect geographically separated organizations and units with a single virtual web. IT-21 strives to achieve software standardization between Navy fleets and

between fleet units and shore-based activities. The Department of the Navy Chief Information Officer Navy-wide intranet initiative coupled with IT-21 warrants a brief discussion of the Defense Information Infrastructure Common Operating Environment.

The Defense Information Infrastructure Common Operating Environment is a set of software applications which are the foundation for Mission Applications. It was developed to make installation easier, reduce integration problems (both competition for system resources and conflicting needs), maintain or improve security, and reduce costs for both hardware and software. The Common Operating Environment's goals are to promote interoperability via access to data independent of its location and function in a reliable and scalable manner, while allowing graceful degradation of capabilities and easily adding new functionality and users. (Cameron, 1997, pp. 4-7)

Any command, organization, or unit that intends to be a part of the Navy-wide Intranet will need to familiarize itself with those requirements and standards that are being set forth to establish this common operating environment.

III. METHODOLOGY

A. INTRODUCTION

Existing strategic planning and process change models provide a general description for designing and implementing change. Three of the models considered as the basis for this project were Functional Process Improvement, The Five Steps of Process Redesign, and Technical Architecture for Information Management. Each of the models was determined to have inadequate detail for this project. Teamed with several other students, the authors of this thesis used these models as a basis for creating a new model, A Heuristic for Describing, Evaluating, and Choosing a C4ISR System.

The Functional Process Improvement (FPI) model (Figure 3-1) used primarily in the Department of Defense, focuses on comparing alternative improvements on a common economic basis (Snider, 1994, p. 3).

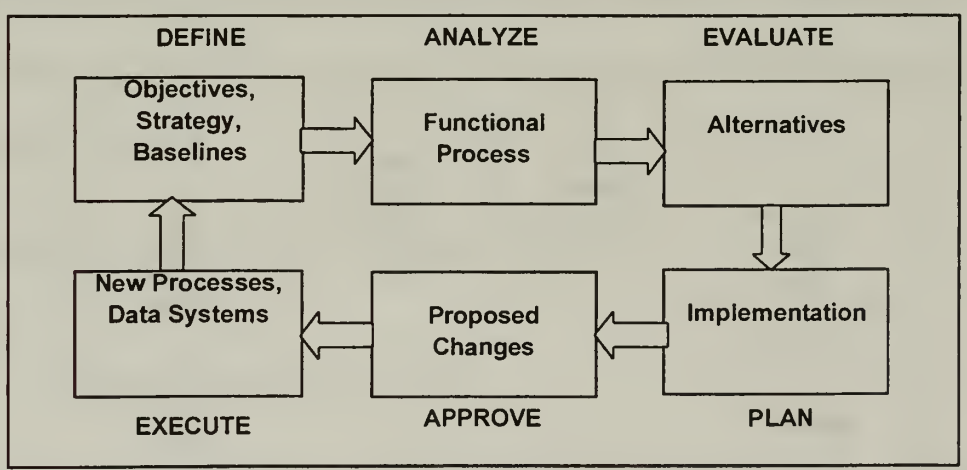


Figure 3-1. Functional Process Improvement Cycle (FEA Guidance, 1992)

Two problems with using the FPI model for this project were immediately evident: 1) IDEF0 evaluation results in a procedural depiction of business functions, rather than an organizational one; 2) factors other than, and in addition to, the economic basis for the evaluation of intranet must be used.

The Five Steps of Process Redesign (Davenport and Short, as cited in Snider, 1994) is a simplified methodology for changing business processes. Except for the scope of the changes taking place, it is similar to Hammer's principles for business process reengineering. The five steps are:

- Develop business vision and process
- Identify processes to be redesigned
- Understand and measure existing processes
- Identify information technology levers
- Design and build a prototype of the process

These steps provide an adequate starting point for organizational change, but seem to be lacking the detail necessary to move successfully through the complete change process.

The Technical Architecture for Information Management (TAFIM) Process was

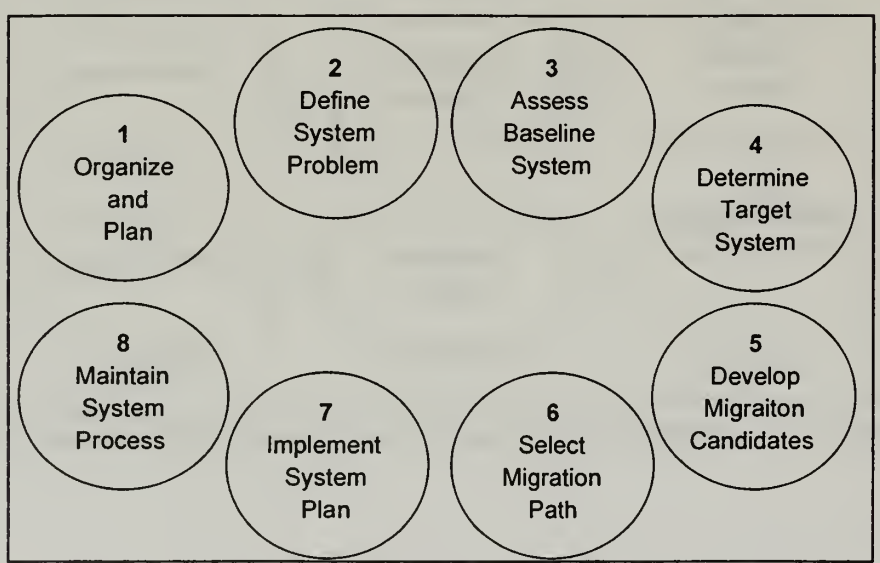


Figure 3-2. Structured TAFIM Process (TAFMOVER.DOC4)

designed to meet the Department of Defense's need for a strategic management process in information technology. The Structured TAFIM Process, is shown in Figure 3-2.

It is a simplified, eight-step process, created from the overall TAFIM Process. This model provided a good basic structure for this project, but a need for increased detail still existed. The Structured TAFIM Process was used as the basic model for creating A Heuristic for Describing, Evaluating, and Choosing a C4ISR System (Baden et al., 1997), which will be used as the model for this project.

B. A HEURISTIC FOR DESCRIBING, EVALUATING, AND CHOOSING A C4ISR SYSTEM

This change model was developed in three phases: 1) looking to the future, 2) developing migration paths, and 3) executing a migration path. The key elements of this change model that make it more usable than other models are the detailed flow chart design and continuous reevaluation process (Appendix B). The scope of this project limited the use of this change model to phases 1 and 2 in an effort to determine whether or not a change would take place. Actual implementation of any change would occur at the discretion of FNMOC.

PHASE I: LOOKING TO THE FUTURE (STEPS 1 – 5)

1. Identify the Need for Change

The first step in making change in any situation is the determination that the status quo is no longer sufficient or appropriate. An overall organizational diagnosis may be

necessary to fully identify the change need. This diagnosis may also serve to identify the key stakeholders as well as identifying change proponents as well as change opponents. It is important to consider the driving forces behind a perceived need for change in order to help determine the real issues at hand. A perceived need for change may result from processes that are no longer adequate, technological advances that might be utilized, or organizational or personal unrest.

2. Develop Future Vision

Developing the future vision is key to framing the solution. Visualizing the ideal future state frames the problem and focuses legacy system analysis. The first step in developing a vision is the determination of who will be the vision architects. A vision could be developed top-down or bottom up, internally or externally. The experts and innovative thinkers must be identified.

The environment that the future system will exist in must then be defined, including where it will be located, whom it will support, and the time frame for implementation. The organizational mission and values must also be defined in order to ensure that only future systems that comply with the mission and values of the organization will be developed.

The next step is the identification of broad future systems capabilities. These are system capabilities that are desired, without considering limitations of current technology or technological trends. These concepts are then filtered into a focused vision that is consistent with the perceived future environment, vision, and values.

Finally, the feasibility of the vision must be considered, technologically, economically, and culturally. If the vision is not feasible, it should be determined if it is the vision or the environment that must be changed to make it feasible.

3. Define Vision Capabilities

Once the vision is determined to be feasible, it is important to define the specific capabilities of the vision. This exercise allows the vision team to set the priorities of the vision. It also makes the vision distinct enough that any reader of the vision can understand exactly where the vision is going and what it is intended to do. Some of the considerations include specifically what the future system will do, what it will look like, and who the stakeholders will be.

4. Identify Current Systems that Support/Could Support Vision

All systems that have capabilities similar to the envisioned system must be considered. In addition, consider any system that could be modified to fit the future system. The identification of these systems is the focal point for determining systems that must be eliminated or changed to achieve the future vision. It also helps in determining how much change will really be needed. Unlike Hammer's original philosophy of radically reengineering organizations, this method only considers changing what needs to be changed.

5. Describe the Legacy System(s)

Describe the legacy systems, which were identified in step 4, in terms of current inputs, uses, decision processes, and outputs. Include any capabilities the systems may have that are not currently being utilized.

A detailed description of the legacy hardware, software, and people is necessary to provide a method for describing the future system and establishing a baseline for comparing the potential migration paths. A model for this detailed description can be found in Appendix B.

PHASE II: DEVELOP AND EVALUATE MIRATION PATHS (STEPS 6 – 18)

6. Identify Resource Constraints

Most projects are constrained by a limited amount of resources in terms of time, money, and people. Determine an outer limit of the resources available for the implementation of the future vision. These limits will be considered when developing possible migration paths toward the vision.

7. Brainstorm Migration Paths

Consider all possible migration paths, subject to the constraints identified in step 6. Encourage divergent thinking and out-of-the box solutions.

8. Identify Factors of Possible Environments

Identify potential environmental scenarios that would impact the migration paths. Include technological, political, and economical scenarios, such as pending technological breakthroughs, budget cuts, elections, and organizational restructuring. These scenarios will assist in the development of future systems that will meet environmental needs.

9. Develop a Possible Future Environments Spectrum

There is a spectrum over which the environmental scenarios are likely to occur. It will be helpful to develop this spectrum for the purposes of evaluating potential migration paths. The actual shape of the spectrum will depend on each scenario's likelihood of occurrence and the criteria used to compare the scenarios. It would be easy to conceive the need to relate these scenarios in multiple dimensions. The environmental spectrum may be used to illustrate the environmental scenario's probability of occurrence. At the peak or peaks lie the most probable scenarios. Moving away from these peaks reduces the scenario's probability of occurrence (Figure 3-3).

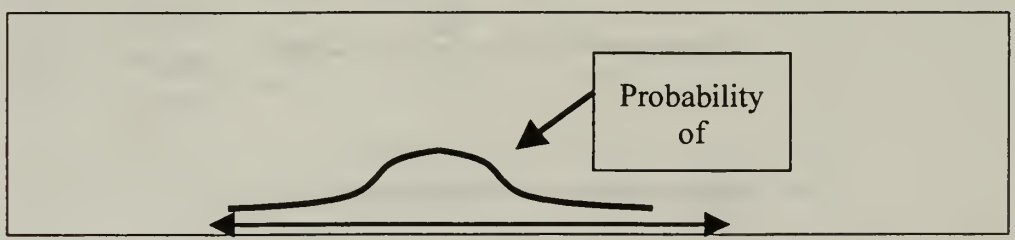


Figure 3-3

10. Correlate Potential Migration Paths with Environmental Scenario

The next step is to correlate the migration paths developed in step 7 with the possible future environments. Conduct this correlation using the same criteria used to develop the environmental spectrum (Figure 3-4).

11. Choose Migration Paths for Evaluation

Combine the results of steps 9 and 10 to create a spectrum of environmental possibilities overlaid with the suitability of the migration paths for the environment (Figure 3-5). The migration paths to be evaluated will lie near the spectrum peaks, or most likely environmental scenarios.

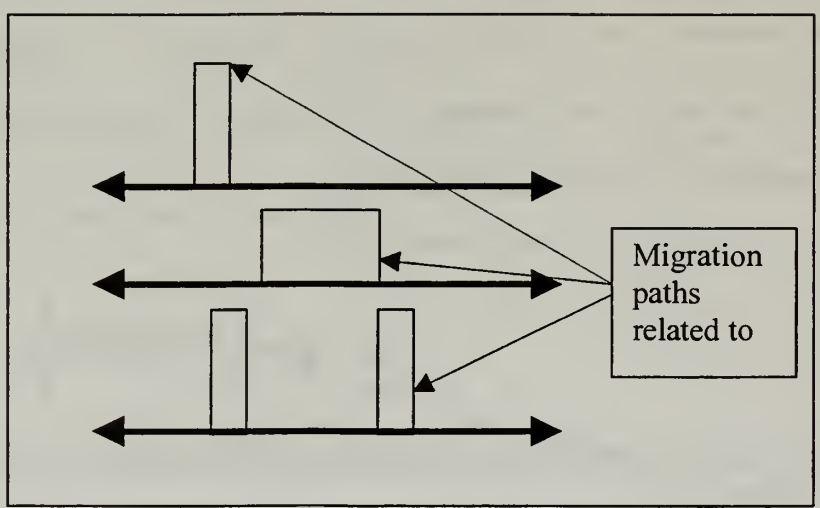


Figure 3-4

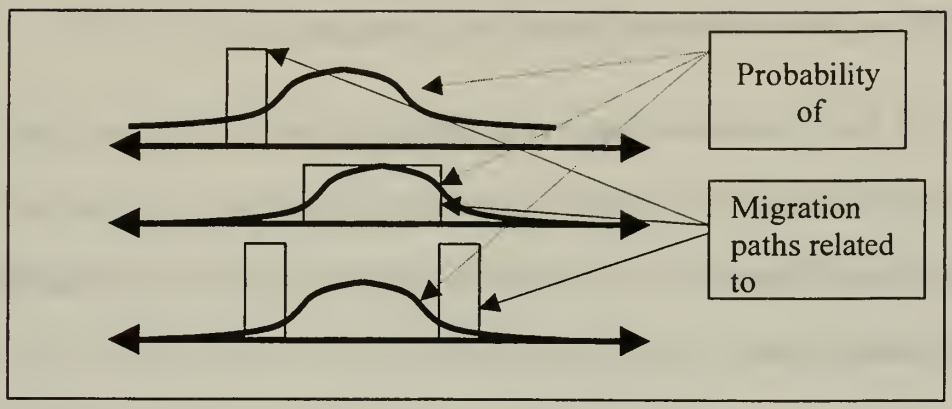


Figure 3-5

12. Select Path for Evaluation

Based on the results of step 12, select one migration path that fits the most probable environmental scenario for detailed evaluation.

13. Describe the Future System Targeted by the Migration Path

Define the expected measures of performance and effectiveness for the future system. Include the evaluation of software, hardware, and people, as related to the future system. Include any pertinent information about best practices in the industry and how it relates to the organization.

14. Identify the Legacy Systems Related to the Future System

Identify the legacy systems from step 5 that apply to the selected migration path. Identify any items for which there is currently no system capability.

15. Obtain Detailed Descriptions of those Systems

If it has not yet been done, create a detailed description of the legacy systems, which apply to the selected migration path; include inputs, processes, and outputs. Use Appendix C to fully define the current legacy system and use it as a baseline to compare possible future systems.

16. Describe the Legacy System Related to the Migration Path

Where applicable, use the information obtained in step 5. If unavailable, repeat the detailed description of step 5 for newly identified legacy systems.

17. Quantify the Relative Differences Between Future and Legacy Systems

In order to fully understand the scope of the differences between future and legacy systems, measures of effectiveness and performance must be established. First, consider the detailed description of the legacy systems in question and determine what measurements can be taken of them; this is the baseline system. Each measure of effectiveness and performance is then applied to the desired capability of the future system. The difference between these two measures will determine the amount of change required to create the future system. In addition, determine which measures of effectiveness and performance do not apply to the future system and what future system measures of performance and effectiveness do not exist in the legacy system.

18. Calculate the Costs, Risks, and Steps Needed for the Migration Path

Development effort, risks, and costs can be represented in a graphical format. Figure 3-6 describes one method of evaluating a migration path's expected development effort. This tool is used by first establishing the baseline. Assuming that the current system is less than the industry standard, the following graphic can be used to show the relative development effort required to reach the goal system.

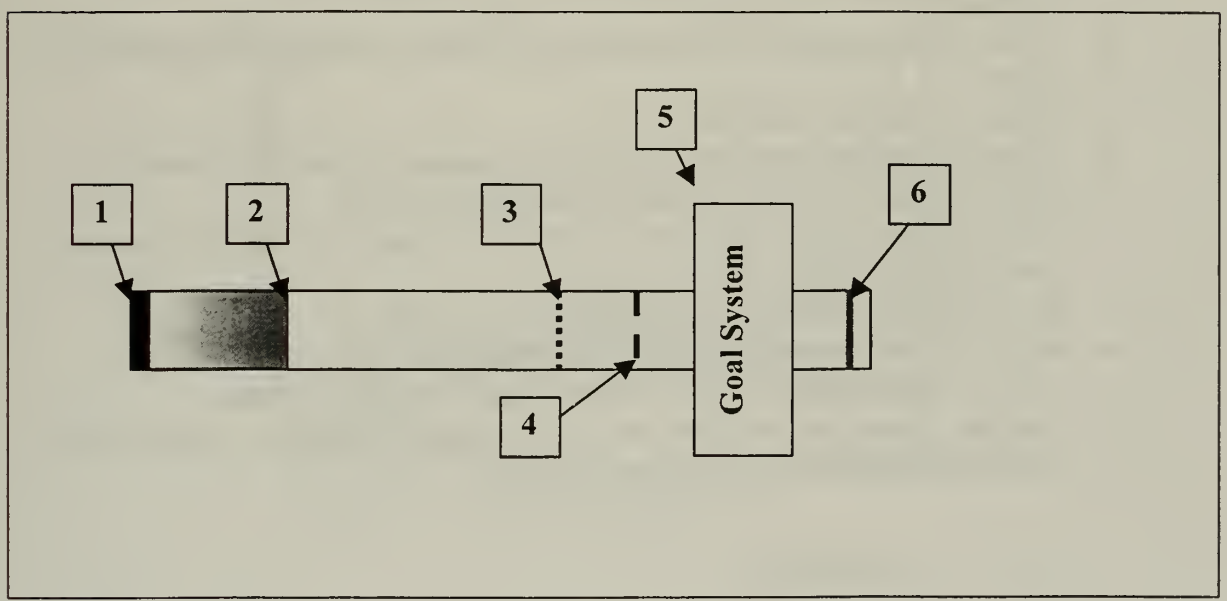


Figure 3-6.

Key
1. Development baseline. This is based on the initial system.
2. Progress bar. This indicates development progressing towards the current industry standard.
3. Current industry standard.
4. Leading edge [technology].

a. Cost/Benefit Analysis

For each of the measures of effectiveness/performance identified in step 17, calculate the following:

- What is the gross cost of achieving the stated goal for the future MOE/MOP, in terms of money and person-hours?
- What is the anticipated return for that cost? Cost/benefit?
- Is the cost feasible and acceptable?
- Score the cost variable for the legacy and future system.
- What risks are involved in pursuing this capability?
- Is the technology to achieve this capability currently available? Is it mature or emerging?
- What is the maximum downside loss that failure to achieve this capability can bring?
- What is its upside potential?
- Is the risk versus reward ratio sufficient to warrant pursuing this capability?
- Score the risk variable for the legacy and future system.
- How long will it take to put this capability in place? Does this fit the time goals of the migration plan?
- Score the time variable for the legacy and future system.
- Is this capability expandable into future upgrades of the system?
- Score the expandability variable for the legacy and future system.
- Sum the scores and compare them to the legacy system or compare each variable individually with the legacy system.

b. Risk Analysis

Technology risk may be modeled by a curve relating technological maturity with the inherent risks of adopting new, less mature technologies and the risk of technological obsolescence. Many people recognize that risk is least when using accepted and proven industry standard technology. This is the marginal risk of change. Risks associated with using less mature technology (e.g., leading edge and bleeding edge technology) increases as the maturity decreases. What is not recognized by many is that lagging behind the industry standard also increases risk. This is the marginal cost of

delaying. Lagging behind industry standard increases the risk of obsolescence. The more obsolete an organization's systems, the more likely they are encounter systems and software that they are unable to interface with or exploit. Additionally, as the organization's system becomes increasingly more obsolete, the greater the investment required to upgrade the system. The technology risk curve may appear as illustrated below. Of course, the shape will depend on the technology considered and the development history and trends.

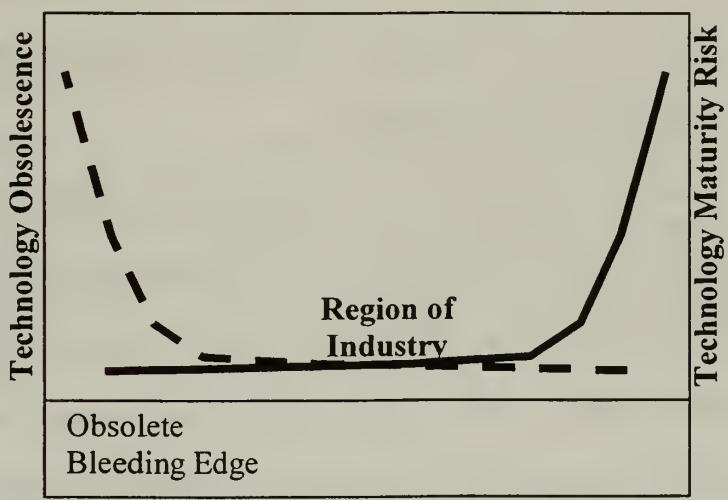


Figure 3-7. Technology Risk Curve

PHASE III: EXECUTING A MIGRATION PATH

Phase 3 of A Heuristic for Describing, Evaluating, and Choosing a C4ISR System was not completed due to the constraints of the project.

C. FNMOC DATA COLLECTION

The Heuristic for Describing, Evaluating, and Choosing a C4ISR System was used as the basis for analyzing the feasibility of intranet implementation at FNMOC. FNMOC employs a broad diversity of personnel; military (officer and enlisted), government civilian employees, and contractors. FNMOC personnel posses a full spectrum of computer expertise. FNMOC also maintains a full spectrum of networked computing technology, ranging from personal computers (PCs) to Supercomputers. This broad diversity of personnel and computing technology allowed evaluating intranet possibilities across a broad spectrum environment.

Research at FNMOC was conducted in two phases. The primary interest of phase one was to familiarize the authors with FNMOC's computing technology. Phase one research consisted of interviews, site visits, and a survey (Booth, Gutsch, Oluvic, Watkins, and Terronez, 1997). The focus of phase two research was to gather information for analysis in determining the feasibility and utility of employing intranet technology at FNMOC. Phase two research consisted of interviews, public deliberation, and a survey.

1. Phase One Research

a. Interviews

Four individuals were interviewed during phase one research: the Director of Network Services, a Network Administrator, the Internal Web Master, and a Computer

Aided Design Engineer. The Director of Network Services and Network Engineer provided insight into the network's logical topology, and plans for future network system upgrades and changes. The Internal Web Master provided information about the FNMOC grass roots intranet effort. The Computer Aided Design Engineer provided information about the network's physical topology.

b. Site Visits

Site visits were conducted to familiarize the authors with FNMOC's Network Operating System (Novell 4.1) and network administration tools. A Network Administrator demonstrated network monitoring from his office with the help of two workstations and network management software (Sun Net Manager). The authors also used this demonstration to gain greater insight into the logical organization of the FNMOC network.

c. Survey

Following the interviews and site visits, the authors found it necessary to conduct a survey to obtain a better understanding of computer nodes and computer users at FNMOC. A review of the network's logical topology found that the majority of the computer users existed on three sub-networks: .20, .21, and .23. The sub-networks are subordinate to sub-network XXX.XXX.60. The survey asked the following questions:

- What type of computer is used at this network node?
- What is the primary operating system of that computer?
- What is the primary use of this computer?
- What applications does the user routinely use?

A random stratified sample of 35 users corresponding to computer nodes on these sub-networks was conducted. The sample size was based on a 90 percent degree of confidence, assuming an estimate of true proportion in the population within ten percentage points and assuming that 85 percent of the population would be using Intel 80486 computers. The survey was conducted during normal working hours and resulted in a non-response rate of zero percent. Survey results are listed in Appendix D.

2. Phase Two Research

a. Interviews

The primary means of collecting data for phase two research was personal interviews. Interviews with the Chief Information Officer identified the need for and the scope of this study. Subsequently, interviews with 42 FNMOC personnel from five different departments were used to help define the intranet vision and the FNMOC cultural environment.

A non-probability purposive quota sample was conducted to select interviewees from each department. The cross section of personnel included each department head and principle assistant, personnel with duties or responsibilities most likely to benefit or interface with an intranet, and a small sample of general working personnel with each department. The interviews provided valuable insight into the culture at FNMOC. The number of interviewees from each department and a list of interview questions can be found in Appendix E.

b. Public Deliberation

As planned, a public deliberation was held to discuss intranet issues, ideas, and concerns. The deliberation was conducted after the initial battery of interviews. This medium was selected because the FNMOC Chief Information Officer had previously successfully conducted public deliberations at FNMOC dealing with information systems related topics. These previous public deliberations were well attended and generated a great deal of constructive comments.

The deliberation was open for participation by all personnel and included a number of individuals who were not personally interviewed. The public deliberation was facilitated by the FNMOC web technologies officer. The authors of this study acted solely as observers, to gather additional information and ideas. In addition to defining the vision and the environment, the public deliberation ventured into the identification of potential migration paths. As a result of comments by deliberation attendees, additional interviews were conducted. The only new concern raised during the public deliberation was a concern about information security.

After the public deliberation and interviews, it was determined that the authors lacked sufficient information to support potential savings and benefits from implementing and intranet at FNMOC. As a result, these questions and others were asked as part of a command-wide survey.

c. Survey

The phase-two research survey was a population-wide, non-probability convenience sample. A non-probability convenience sample was selected due to the ease

of administering the survey to the entire population (~280 computer users) by using electronic mail.

The purposes of administering the survey were: to determine the current level of computer expertise, web publishing expertise, and Internet/intranet browser proficiency in the command; to ascertain the current level of paper printing and reproduction; to obtain user perceptions of possible reproduction costs if an intranet were implemented. The questions relating to printing and distribution costs were asked to determine if FNMOC could experience savings similar to that experienced by the Sandia National Laboratory.

The survey achieved a forty-nine percent response. Responses reflected a representative cross-section of the command from the front office to the most junior military and civilian personnel. The survey can be found in Appendix F. A partial list of the results can be found in Appendix G.

3. General Intranet Research

Concurrent with the study of FNMOC, the authors conducted an extensive study of intranets in commercial organizations, intranet best practices, intranet implementation strategies, organizational change management, and intranet initiative and issues in the Department of Defense. The majority of this research was done on the Internet, which led the authors to a number of recently published books and white papers. Additionally, previously published Naval Postgraduate School theses and current periodicals were used.

IV. FINDINGS

The project began with an attempt to develop an understanding of the mission, organizational structure, and network architecture at FNMOC. This information was used as the basis for the study of whether or not FNMOC should implement an intranet and, if so, what resources would be required to do it. In this section the authors begin with an overview of the organization's mission, structure, and background, which are used in conjunction with interviews and surveys to perform a diagnosis of the FNMOC organization.

A. MISSION

As the Defense Department's principle operational processing center for meteorology and oceanography analysis and prediction, FNMOC maintains the most complete database of oceanographic and atmospheric observations in the world. FNMOC produces oceanographic and atmospheric analyses and forecasts for Navy and Marine forecast sites, deployed ships and units, the Air Force Global Weather Central, and a variety of other organizations around the world. (Fleet Numerical Meteorology and Oceanography Center, 1996)

The Fleet Numerical Meteorology and Oceanography Center mission is:

> To provide computer-generated descriptions of the air-ocean environment to operating forces, anywhere, anytime. (Fleet Numerical Meteorology and Oceanography Center, 1996)

Fleet Numerical fulfills this role through a suite of global and mesoscale meteorology and oceanography models, extending from the top of the atmosphere to the bottom of the ocean, that are supported by the world's most complete real-time meteorology and oceanography database.

B. ORGANIZATIONAL STRUCTURE

FNMOC is comprised of 45 military officers, 55 enlisted personnel, and 175 civilian employees. The majority of the work performed at FNMOC requires employees to be highly skilled and technically proficient. In the areas of product and model development a high degree of innovative thinking is also required. The average length of employment at FNMOC for civilian employees is 15 to 20 years. With this rate of longevity and experience, civilian employees become quite knowledgeable and self-sufficient. The average length of time on station for military personnel is three years.

The authors used the FNMOC command information packet to develop the following organizational structure. Although the organizational structure has been modified through a realignment, the basic research for this project is based on the following information. Prior to realignment, the organization was divided into eight units:

- Commanding Officer
- Resources Directorate
- Operations Department
- Models Department
- Computer Systems Department
- Communications/Technology Integration Department

- Data Department
- Enterprise Program Office

The Commanding Officer is responsible to see that the mission of the organization is carried out. This unit consists of a military Commanding Officer and Executive Officer, a civilian Technical Director, and a support staff that is both military and civilian.

The Resources Directorate advises and assists the Commanding Officer and provides services to the entire command in several functional areas related to command management and fiscal execution. The Resources Directorate manages an annual Operations and Maintenance, Navy (O&MN) budget of more than 20 million dollars. The Resource Directorate unit consists of nine divisions: security, training, administration/civilian personnel management system, facilities, external affairs, supply, fiscal affairs, procurement, and library services.

The Operations Department is the hub of Fleet Numerical's global fleet support. This group of 60 military and civilian personnel provides both routine and tailored METOC support to Department of Defense and allied forces worldwide. The Operations Department has six divisions: weapons system support, operations, tactical services, routing services, special intelligence communications, and system application production.

The Models Department implements and maintains all meteorological and oceanographic (METOC) models at Fleet Numerical. The Models Department is

comprised of meteorological models, oceanographic models, and quality assurance divisions.

The Computer Systems Department is responsible for the 24-hour operation of Fleet Numerical's supercomputer center, including hardware maintenance, operating systems support, and computer operations personnel. The computer center boasts a wide variety of equipment ranging from microcomputers and workstations to medium and large-scale supercomputers. The Computer Systems Department consists of four divisions: systems support, automated data processing (ADP) production, networks, and computer equipment support.

The Communications/Technology Integration Department is responsible for the daily receipt of all METOC observations and for transmitting all messages, images, and gridded or observational products. Communications responsibilities include integrating and managing communications systems, distributing products to five operational METOC centers, distributing products to the fleet, and dialing in to access various systems. Technology integration involves assimilating new hardware and software technology into the command for improving productivity and efficiency, establishing command-wide software standards, maintaining configuration management of all software, and managing database management systems. The three divisions in this department are software technology, data administration, and communication support.

The Data Department is responsible for providing conventionally and remotely sensed data to all numerical models and applications. It acquires, sorts, and decodes over

two million meteorology and oceanography observations per day. The Data Department develops and maintains the satellite data processing software to provide data to the numerical models as well as satellite imagery to customers around the world. The Data Department has five divisions: data management, data acquisition, satellite, special products, and data distribution.

The Enterprise Program Office is a group of Program Management personnel whose function is to manage the planning, design, acquisition, installation, support and maintenance of Information Systems at FNMOC. This unit provides support to the Enterprise Group, which functions as FNMOC's visionary group. The Enterprise Group reports to the Technical Director and consists of all of the department heads.

Department head positions are assigned to military officers. Departmental deputies assist department heads and are assigned to civilian personnel in order to maintain continuity within departments and accommodate for the high turnover rate of military personnel.

According to the information available, seven of the departments (not counting the Commanding Officer) are divided into at least 30 divisions. It was discovered during interviews with employees that some of these divisions consist of only three to five employees, all of whom may be working independently. It was also discovered that there is a lack of communication across departmental and divisional lines.

Two months after this project began the authors learned that FNMOC personnel were already in the process of implementing an intranet, a process of which the Chief

Information Officer was unaware. A grass-roots effort to share information through an intranet was already underway and the network division had purchased the hardware and software it required as part of a planned upgrade. When top management learned of the intranet effort, they ordered all intranet use and development be terminated until this research project was completed and a command decision was made.

Lack of communication at FNMOC also results in duplication of effort. Both the Operations Department and the Communications/Technology Integration Department are responsible for managing and updating FNMOC's Internet home page. The Communications/Technology Integration Department owns the database of observations, yet the Data Department is responsible for processing the incoming observations and translating the data.

The fragmented nature of FNMOC is also evident in a system where the Communications/Technology Integration Department develops software, the Operations Department tests it and uses it on the watch floor, and the Computer Systems Department maintains it. It is not uncommon for communication routings to change without the knowledge of the watch section, making troubleshooting an outage nearly impossible.

Communication is not the only issue. Even when there is communication, there is duplication of effort. A command-wide form called a configuration change proposal is used to track work requests in the command. Rather than utilizing one system, the Data Department and the Communications/Technology Integration Department have developed their own systems.

In spite of the traditional military hierarchy and the communication problems and power struggles associated with it, FNMOC must contend with another issue. It is common for a FNMOC employee to work on multiple project teams with employees from other departments and divisions. Because of this, employees are required to develop some form of communication across departmental and divisional boundaries, as one employee stated: "In general, most projects in the command will cross department/division boundaries and require a mix of talent to accomplish."

This communication requirement was the impetus for the initial development of an intranet communication tool. Project group members found it easy and efficient to communicate with other group members through project web pages. The Joint METOC Viewer (JMV) project is one example of a FNMOC project that crosses departmental and divisional boundaries and used a web page to share information. The purpose of this project is to create a browser-based application to allow clients to download and display FNMOC products. The C4I Systems Engineering and Integration division of the Communications/Technology Integration Department and the Routing Services division of the Operations Department manage this project. Routing Services is responsible for operational testing and the C4I Systems Engineering and Integration division is responsible for development. Communication between the two divisions is essential because Routing Services is the best source for requirements definition and C4I Systems Engineering and Integration has the needed technical expertise.

In order to better accomplish the mission and reduce organizational fragmentation, the organizational structure at FNMOC is in transition. After being established in the command for a year, the Commanding Officer has instituted a realignment of the organization. The structure of the realignment was recommended by the previous Commanding Officer. The main difference between the old structure and the new is the combination of several departments. The Models Department and the Data Department have been combined under a single department head. The Computer Systems Department and the Communications/Technology Integration Department have been combined under another. (Rich, 1997)

The key success factor at FNMOC is getting the right products to the right people at the right time. Oceanographic and atmospheric forecast are perishable; if the data is not compiled and sent at the proper time, it becomes obsolete. To accomplish this critical task, FNMOC operates 24 hours a day, 365 days a year. Data processing must be well developed and maintained, and the oceanography and meteorology models must be accurate. New models and products are continuously being developed.

There is a high degree of interdependence throughout the organization. The entire FNMOC mission is dependent upon computer and network reliability and accessibility for product development, data processing, modeling, and operations. Products and models are dependent upon the processing of satellite observations, and the exchange of observations and data into and out of FNMOC is dependent upon communications

integration. An organization that is so highly interdependent must have good communication and information sharing tools.

The Chief Information Officer and a number of FNMOC employees believe that the intranet is the tool that could greatly enhance organizational communications. Senior management believes that it would cost too much to implement and would be another information dissemination burden.

C. TECHNOLOGICAL INFRASTRUCTURE

FNMOC maintains a high-power computing facility. Two Cray super-computers provide the support and processing for the organization's mission. This mission is supported by more than 350 microcomputers and workstations for product and model development, communication, and administration. The local area network, which spans the organization, supports classified and unclassified network traffic. (Fleet Numerical Meteorology and Oceanography Center, 1996)

A fiber distributed data interface (FDDI) backbone connects the majority of the network at Fleet Numerical Meteorology and Oceanography Center. It exists in and between three buildings: 700, 702, and 704, in a campus-like layout. Building 700 houses a Cray C90 computer and the Operations Department and accounts for the majority of the network activity. Buildings 702 and 704 are used primarily for administration and product development.

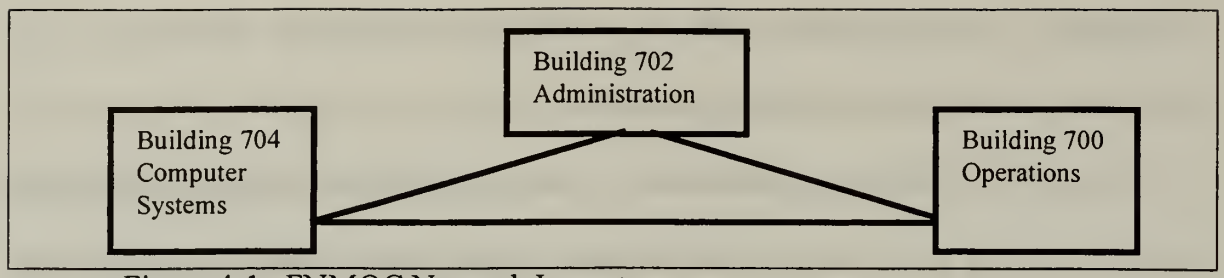


Figure 4-1. FNMOC Network Layout

FNMOC personnel were unable to find a current diagram of the physical layout of the local area network. The most current available diagram of the network configuration for Fleet Numerical Meteorology and Oceanography Center is dated March 16, 1996. This diagram provides a good general understanding of the network configuration, but a number of changes have taken place since its publication. Figure 4-2 is an abbreviated version of that diagram.

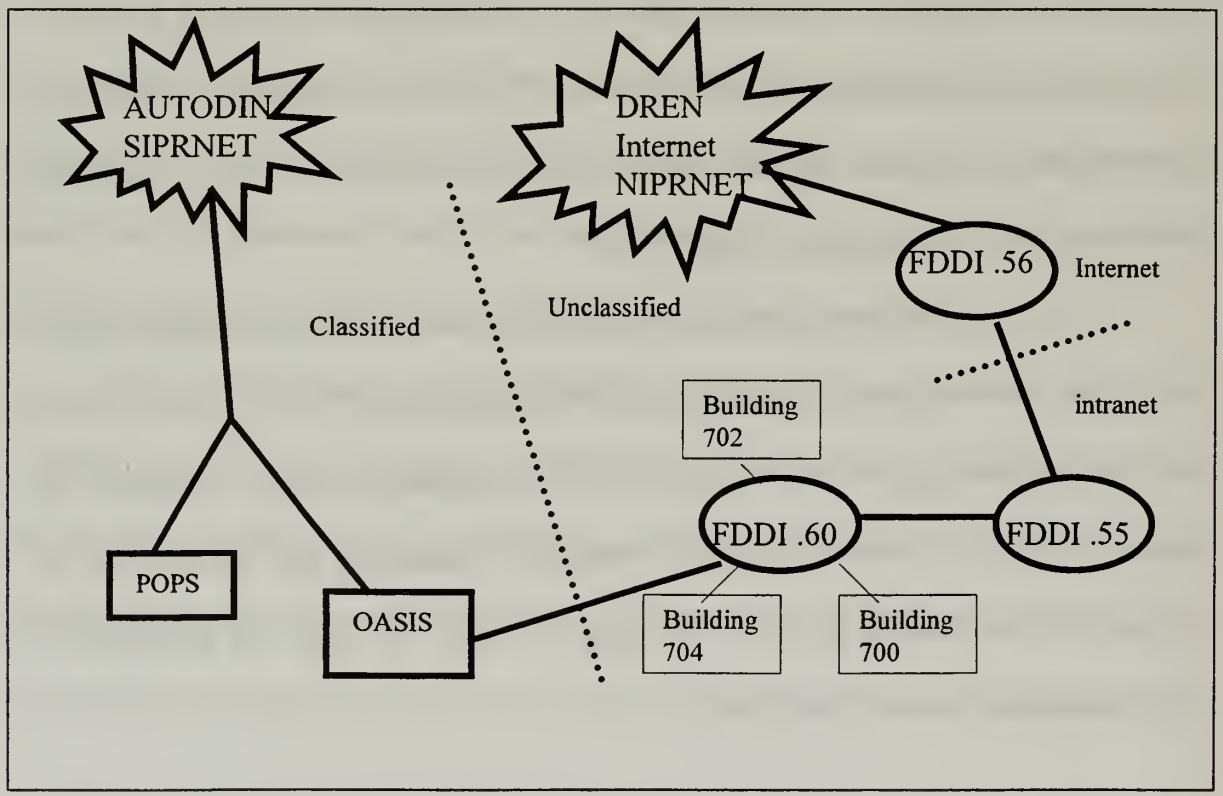


Figure 4-2. FNMOC LAN Configuration

Classified operations take place on the POPS and OASIS portion of the network. This portion of the network contains the Cray computers and is secured from the rest of the network by the Cray's multi-level security operating systems. The unclassified portion of the network is separated from the Internet and other external systems by a firewall that is established by a choke router between FDDI .56 and .55. The majority of unclassified information flows around FDDI .60. This section of the network would be the focal point of an intranet.

In an effort to meet the needs and demands of its customers and employees, FNMOC is in a continuous process of technological upgrade. One of the components of an upgrade that is in progress is the collapse of the site-wide backbone and a migration to a switched environment. This upgrade is designed to alleviate network congestion and speed up network traffic. Due to a lack of funding, this upgrade has been temporarily put on hold. Without this upgrade, would the FNMOC network be able to support an intranet?

There are a number of methods available to reduce network congestion besides the migration to a switched environment. One method is decentralized processing. It was discovered that one of the causes of network congestion was that the Windows for Workgroups operating system was being run from a central server. When users needed to access the Windows environment they had to reach out across the network for it. Once the operating system was installed on each computer, network traffic was greatly reduced.

Another method of reducing network traffic is the distribution of network services. As part of the network upgrade, FNMOC is installing four Pentium 200 MHz, dual-processor servers. If these servers are strategically placed in the network, the majority of network traffic can be contained. The recommended placement would be to have one server in each building. These servers would contain the majority of files and services to which the employees in that building would need to access and could also act as intranet web servers.

A study of software and operating systems revealed that there is little software standardization at FNMOC. A random stratified sample of employees who are connected to administrative sub-networks on FDDI .60 was conducted. Results indicated that like many organizations, FNMOC maintains a variety of computer systems. Employees use five types of computers: Apple, 40386, 40486, Pentium, and Unix. They use six different operating systems: Apple, MS-DOS, Windows 3.11, Windows95, and WindowsNT. Nearly all of the employees interviewed use electronic mail and word processing programs. Half of them use spreadsheet, database, graphic, and web browser applications. In some cases employees who work primarily on Unix systems have a separate computer solely for checking electronic mail and bulletin boards. (Booth et al., 1997)

Each of these computer types, operating systems, and applications equates some level of cost for administration and upgrade, costs which standardization could reduce. An effort to standardize operating systems and applications programs at FNMOC is

underway. All 40486 computers will be upgraded to Windows95 and all Pentiums will move to WindowsNT. Apple and 40386 computers will be phased out. Microsoft Office97 is designated to be the standard application package, with Netscape Navigator as its browser. FNMOC is currently using Novell IntranetWare 4.11 as the network operating system and is considering the implications of IT-21's requirement for WindowsNT Server 4.0.

When the new servers are configured and installed and the standardization project is completed, all employees will have the necessary hardware and software to connect to and use both the Internet and an intranet. Windows95 and WindowsNT are configured with protocols to access the network, Microsoft Office97 has built-in web publishing tools, and Netscape Navigator allows web browsing and access to electronic mail. All of the licenses for this upgrade have already been purchased. The only additional cost for intranet tools is a more sophisticated web authoring tool, such as Microsoft Front Page, and a management tool to check for indexing and document links.

D. INTRANET VISION

Interviews with FNMOC employees enabled the authors to compile a vision for a FNMOC intranet. A FNMOC intranet:

- Is a repository of information, available to any employee at any time. Its very existence encourages information sharing and increases the knowledge base of the organization.
- Allows fast and easy communication across departmental boundaries and eases the burden of project team coordination.

- Encourages cross talk throughout the organization eliminating the problem of "re-inventing the wheel."
- Improves fnmoc products by allowing in-house evaluation of products destined for the internet.

More than 90 percent of the employees interviewed indicated that an intranet would greatly enhance their job performance. The three predominant areas where an intranet would be beneficial are watch floor support, general administration, and information sharing.

1. Watch Floor Support

FNMOC's primary mission is implemented on the watch floor. FNMOC receives more than two million meteorological and oceanographic observations each day. These observations are preprocessed and decoded into the proper format for input to mathematical computer models. The models are then used to generate thousands of output products, which are formatted for specific users and distributed to them. The watch team is responsible for monitoring the flow of data, model output, and the status of all computer and communication systems. They are also responsible for quality control of models and products, as well as providing on-line support to FNMOC customers.

Due to the perishable nature oceanographic and atmospheric data and forecasts, real-time support of the watch floor is needed. It is not uncommon for communication routings to change on a daily basis. These changes are made outside of the watch floor and are often not documented or are documented after-the-fact. When the watch team

discovers an outage, they need to know what the actual routing is in order to troubleshoot and repair the problem. Without up-to-date information about the routing, they are unable to repair it and must call someone in to help. If the routing changes were posted on an intranet when they were implemented, the watch team would have immediate access to the information and be able to correct the problem quickly without having to call anyone in.

It is important for members of the watch team to understand the models and products that are created and distributed. Because of the number of models and products, the fact that new ones are continuously being generated, and because some watch members only stand duty several times a month, it is difficult to remember all of the information. If products and models were posted on an intranet, the watch team would have access to product and model information anytime it was needed.

Military officers who report to FNMOC for duty are required to qualify for the position of Command Duty Officer (CDO). The CDO is responsible to oversee the watch team and monitor watch floor operations. Command Duty Officers stand a 24-hour watch several times each month. Their primary assignment is a day staff position outside of the watch floor. The qualification process for a CDO takes three months. During that time he/she is assigned to a watch team to complete the Job Qualification Requirements (JQR). The JQR is a list of information and tasks that the officer must know and perform during oral and written exams.

The process of completing the JQR has been described as a "scavenger hunt." All of the information the officer needs is not readily available on the watch floor. The task is as much about finding out where the information is or who has it in their head as it is about obtaining the information itself. Each officer creates a large binder of information in the hopes that when called upon as the CDO he/she will have the information they need. Unfortunately, due to the changing nature of models, products, and communication routings, the binder is quickly out-of-date. With the help of an intranet, CDO training could be accomplished more quickly and easily. A CDO information page on an intranet would provide every officer with the same up-to-date information. Each officer would not have to create a separate binder of quickly outdated information. A CDO information page would allow officers to review current CDO information prior to standing the watch, making them more valuable members of the watch team.

2. Information Sharing

Inter-departmental communication and information sharing takes place through electronic mail (ccMail) and bulletin boards, with electronic mail being the tool of choice. An organization-wide survey indicated that 98 percent of the respondents check their electronic mail at least daily, with 83 percent checking it several times each day. The electronic mail system has 360 local users, with 1500 users claimancy-wide. Thirty-

seven percent of the respondents feel that they receive too much email. During an interview one individual indicated he received 114 messages in one day.

Seventy-five percent of the traffic on the local area network is electronic mail, 20 percent of which is junk mail or postings to all employees. An intranet would reduce the amount of electronic mail because intranets operate on a pull versus push concept. Information that is posted on an intranet is available at the request and convenience of the user. Although it may not actually reduce the level of network traffic, it will make network traffic more user-driven.

The bulletin board system is less widely used than electronic mail. Thirty percent of the survey respondents find that the ccMail bulletin board system is not useful or simply choose not to use it. Interviews revealed that the bulletin board system occupies 50 megabytes of ccMail and consists of 48 pointers, each with its own manager. Because the bulletin boards do not follow a standard naming convention, finding a specific file is difficult unless the exact file name is known. Because it already exists in electronic form, bulletin board information could easily be converted to intranet with logical pointers from appropriate web pages, making the information more easily accessible.

Interviews showed that the most common concerns regarding the implementation of an intranet were information management and ownership. One interviewee stated her perception of information as power at FNMOC: "The culture around here is that nobody needs to know about 'it' until 'it' is ready." Despite the interactive nature of project

groups and interdependent task structures, the lines of authority and responsibility are held tightly. Power struggles develop along the boundaries of the organizational chart.

An intranet is only an information-sharing tool. It alone will not solve cultural power struggle issues. The implementation of an intranet, in conjunction with the organizational realignment, provides FNMOC managers with an opportunity to change the perception of information from personal property to an organizational asset. If the perception of the value of information sharing does not change, the realignment of the organization and implementation of an intranet will eventually drift back into a segmented stovepipe organization.

3. General Administration

FNMOC maintains a large repository of documents and instructions, many which are already in electronic form. It is the hope of FNMOC employees to have them in a format that is easy to access, use, and update. Some of these documents are saved and stored on Devu I, a file server on the operational network. Although information can be saved and stored on Devu I, it is not accessible to all employees and it is not supported or maintained. Other documents like briefings and presentations are available on the O-drive for access and updating. It has been suggested that this information would be better utilized if it were stored on an administrative network and made available to all users through an intranet.

Numerous suggestions for using an intranet as a common source for documentation were made during the interviews. The Standard Operating Procedures manual is one of the most important documents used in support of the watch team. These procedures detail the function of the watch floor and the steps to take in the event of an outage. Keeping this manual up-to-date is a full time job. Every change that is made must be approved and distributed to all copies of the manual to replace old documents. If it were stored on and accessible through the intranet, the only paper copy that would need to exist would be on the watch floor as a backup in case of a computer outage. The manual could be updated through the intranet and be immediately available to all users.

Meetings that are called to discuss projects, policies, and procedures would also benefit from a common document source. One meeting for the Defense Messaging System (DMS) integration project was called to review and revise the DMS transition plan. During this eight-person meeting, it was discovered that they had brought with them three different version of the plan. Each came from a different source. Consequently, the discussion had to be postponed until all members had reviewed the same version of the plan.

Any document that must be updated and distributed to employees could be kept on and accessed through an intranet, eliminating the need to replace copies throughout the organization and ensuring that all employees have the most recent version of the document available.

E. CHANGE READINESS

Prior to the implementation of any major change, an assessment of the organization's readiness to change must be conducted. A successful change requires that the change is consistent with the organizational mission and objectives, meets the needs of the stakeholders, and is embraced by all those affected. In order for a successful change to take place, organizational readiness for change must be greater than the marginal cost to implement the change. Change readiness has three components: the level of employee dissatisfaction with the status quo, the organization's change culture, and the strategy used to implement the change. The marginal cost of change has two components: the cost of change and the cost of not changing.

1. Dissatisfaction

The energy and motivation for change comes from the loss of confidence in the status quo (Beer, 1988). This loss of confidence can often be attributed to changes in the environment, internal or external, that are not met with adequate organizational adaptation. These environmental changes include, but are not limited to, technological innovation, changing market conditions, and changes in personnel. It is becoming increasingly evident that since the only thing constant is change, the challenge comes not in creating change, but in adapting to it.

The employees at FNMOC tend to be enthusiastic, energetic, frustrated, and skeptical. When employees are enthusiastic and energetic they see potential for growth

and improvement for themselves and for the organization, keep up-to-date with current technology and trends, and feel they add value to the organization. They become frustrated and skeptical when they learn that change does not come quickly, if it comes at all.

Employees at FNMOC have reached a high level of frustration and dissatisfaction. One cause of frustration is the duplication of effort. During an interview, one employee exclaimed: "The duplication effort is huge!" Another said: "There are a lot of overlapping responsibilities in the departments." A third explained: "The division chief wants to do 'it' a little differently in order to 'claim fame' to it."

Another cause of frustration is the availability of information. Employees feel that information is difficult to obtain and, in many cases, available to only a select few. "Information is only for those who know where to get it. The bulletin board naming convention is meaningless." It was also indicated that some information exists "only in the head of the programmer."

Additional sources of frustration for FNMOC employees are a lack of understanding of "how things fit together" in the organization and a feeling of being "held back" from exploring new ideas. Some employees feel under-utilized, while others feel over-worked. Some employees push for change, while others feel it is futile to try anything. FNMOC seems to be oscillating in an area of tolerable conflict where attempts to leverage technology are stifled by a culture opposed to growth and change. The high

level of dissatisfaction with the status quo that currently exists at FNMOC is a strong indicator that it is the right time for change.

2. Culture

The second component of the change formula is the cultural predisposition to change. Some organizational cultures adapt more readily to change than others. These cultures tend to have evolved into learning organizations where systems thinking is the norm, personal mastery is encouraged, mental models are challenged, shared visions are created, and team learning is valued (Senge, 1994, pp. 5-10).

Culturally, FNMOC does not rate very high on the change readiness scale. Departments and divisions operate on their own agendas with little thought given to the overall mission and vision of the organization. Only those who are driven beyond organizational expectations achieve personal mastery. Mental models of what can and cannot be done and how things should be done are deeply entrenched in the organization. Shared visions are often stifled and teamwork is evident only on specific projects.

In most cases, an organization such as this would not be ready for change. In this case, FNMOC is in the midst of an organizational realignment, which has been implemented from the top-down. This unsettling has created an excellent opportunity for the implementation of an intranet. The intent of the restructuring is to improve communication and information sharing within and between work groups. An intranet can do just that. Employees at FNMOC have been forced into a "neutral zone." A neutral

zone is that place in time where an organization is no longer what it was, and is not yet what it hopes to be. "It is in the neutral zone that people and organizations have the opportunity to be most creative" (Bridges, 1993, p. 61). Now is the time for FNMOC to utilize intranet as a tool to redefine the organization and culture for optimum information sharing and teamwork.

3. Process

The third element of the model is the process by which change takes place. The process of change is a sequence of events that take an organization from the current state, through a state of transition (neutral zone), into a desired future state. This process is the key to creating enthusiasm for change and obtaining user buy-in for the change. Regardless of whether a change takes place from the top-down or the bottom-up, a high commitment for change from the stakeholders is the most important element for change success.

a. Commitment to Change

Change that is viewed by employees as in their best interest is change that employees will support. Factors in the change process that may impact employee commitment to change include who decides what will change, what kind of change it is, and how the change is implemented. The most common technique of gaining employee commitment is to have employees participate in the entire change process: determining

what the change will be, planning and implementing the change, and evaluating the change after it has taken place.

The organizational realignment at FNMOC was based on a top-down approach. A new organizational structure was distributed to the organization and a timeline for implementation was instituted. Top level changes in departments were instituted, leaving many questions about the inner workings of the newly defined departments. The department heads are tasked with redefining and updating the internal structure of the departments.

While this method may not encourage employee commitment, it requires employee compliance. The implementation of an intranet at the same time as the realignment can bridge this gap between commitment and compliance. Employees who are encouraged to become a part of the realignment through the redefinition of the information sharing and communication structure and implementation of an intranet will be more likely to understand the value of the realignment and commit to it.

b. Resistance to Change

One of the basic goals of the change process must be to reduce or eliminate employee resistance to change. Four of the basic elements of resistance to change include individual tolerance for change, personal sense of security, extent of loyalty and trust, and cultural beliefs and experiences. These all affect how an individual will react to change (Bryant, 1979).

The resistance to change, regarding an intranet, that exists at FNMOC can be attributed to the longevity of civilian employment, distrust of military management, and historical experience with failed projects. Employees who have been with the organization for a lengthy period of time have become used to and comfortable with the way business has been conducted. One interviewee asked: "If I can put it on a clipboard, why use a computer?" Another employee stated: "Managing doesn't require computing."

Although most employees support the installation of an intranet, there are some that are skeptical about the amount of support that an intranet might get from upper management. It is believed that there is "no upper management buy-in for software engineering in general" and without the support of upper management, an intranet can never be successfully implemented. The historical record of successful project completion also has many employees skeptical that an intranet can really happen. One employee stated: "It will not be kept up or maintained. It will only get half done and then it will be dropped. It happens all the time." Another offered: "many FNMOC projects do not have defined requirements. Eventually, both time and money runs out before projects are completed."

4. Cost of Change

It is important to remember that any change process must consider both technical and social issues. Technically, change is easy. The costs associated with technical

change involve quantifiable resources: money and person-hours. Socially, the cost change is very complex and is not quantifiable.

a. Technical Cost

The platform independent nature of an intranet results in 100 percent information accessibility using a single client software package (assuming that all computing platforms are loaded with appropriate communications protocols and web browser). The current system provides segmented accessibility. Approximately 30 percent of computer users access the network using UNIX platforms, while the majority of the remainder use IBM compatible PCs. Most of administrative information is shared on the PC portion of the network. Access to the administrative information by 30 percent of the computer users requires the use of separate computing platforms, while access to the development information requires additional software applications. Thirty percent of survey respondents indicated that they either found the bulletin board system useless or chose not to use the system. Interviewees often commented on the difficulty in finding information on the bulletin board system. The intuitive nature of web browsers and hypertext documents removes these obstacles, making this information readily accessible to 100 percent of the users wishing access. Finally, development of new internal applications will require developing a front end for a single client application to achieve 100 percent information accessibility. To achieve 100 percent information accessibility using legacy systems would require developing as many as six separate application

interfaces to accommodate the six different operating systems in use at Fleet Numerical Oceanographic and Meteorology Center.

There are no hardware and software costs for Fleet Numerical Oceanography and Meteorology Center's setting up a level I intranet. However, acquiring web site creation tools and maintenance software will likely reduce the effort required by departmental web barons to set up and maintain web sites. Assuming a maximum number of ten web site creation and maintenance software packages at an approximate cost of $150 per license brings the total additional hardware and software costs to $1500.

The personnel costs for setting up four intranet web servers is four man-hours times four servers times the Full Time Equivalent salary (per hour) for a federal employee. The majority of the federal civilian employees at Fleet Numerical Oceanography and Meteorology Center are pay grade GS-12. The personnel cost, for setting up four web servers, is as follows:

$$FTE(GS12/hour) = \frac{\$50{,}948/year}{2080 hours/year} = \$24.50/hour$$

$$Cost/Server = 4 hours \times \$24.50/hour = \$98$$

$$Cost(4\ \text{Servers}) = 4 \times \$98 = \$392$$

The personnel cost of setting up web browsers is approximately ten minutes per client. Of the roughly 280 employees working at Fleet Numerical Oceanography and Meteorology Center, 83 percent work in an office environment where they are not required to share computers. Of these, 52 percent are not TCP/IP ready. The cost of installing browsers on these office computers would be:

$$Cost(BrowserInstall) = 280 employees \times 0.83 \times 0.52 \times 10\,\text{min} \times {}^{1hr}/_{60\,\text{min}} \times {}^{\$24.50}/_{hr}$$

$$Cost(BrowserInstall) = \$493$$

Total personnel costs for setting up the web servers and browsers is approximately $1000:

$$Cost(4\,\text{Servers}) + Cost(BrowserInstall) = \$392 + \$493 = \$885$$

A complete estimate of personnel costs for initial intranet setup includes the following:

- Software Install — 50 person-hours
- Structure Design — 14 person-hours
- Policy Development — 10 person-hours
- Basic Web Page Development — 3 person-hours
- Initial Web Construction — 15 person-hours
- 1st two levels
- Document Conversion — 10 min per document
- BBS Conversion — 10 min per document
- New/revised web training — 1-4 hours per person

The ongoing costs of maintaining the intranet are expected to be no more than four hours per week per server and could be as little as 30 minutes per week (Ravid, 1997). Dividing this workload between a Fleet Numerical Oceanography and Meteorology Center intranet web master and four web barons requires at most a total of twenty person-hours per week in maintenance costs. These costs could easily be offset with as little as an average of one minute per day increased productivity.

$$280 employees \times 1 \text{ min}/_{day} \times 1 hr / 60 \text{ min} \times 5 \, {}^{days}/_{week} = 23.3 hours$$

The break-even point for this investment can be calculated using the equation:

$$Sales(time) - (VariableExpense(time) + FixedExpenses) = \text{Profits}$$

or

$$Sales(time) = VariableExpenses(time) + FixedExpenses + \text{Profits}$$

$$(time) = \frac{FixedExpenses + \text{Profits}}{Sales - VariableExpenses} = \text{Break - Even Point}$$

For the purposes of calculated in break-even point, profits are assumed to equal zero. Sales is the variable for the value of productivity increase. It is assumed as one minute per day per employee, or 23.3 hours per week. Variable expenses are assumed to be the weekly expense of maintaining the intranet. Fixed expenses are

assumed to be the expenses of initially setting up the intranet. Given these assumptions, the break-even point for this intranet is 12.4 weeks.

$$\text{Break} - \text{even} = \frac{\$1000}{\left(23.3\,{}^{hrs}/_{wk} - 20\,{}^{hrs}/_{wk}\right) \times \left(\$24.50\,{}^{/}_{hr}\right)}$$

$$\text{Break - even} = 12.4 weeks$$

b. Social Cost

The social cost of change is more difficult to calculate. In order to develop a culture in which information is a corporate asset employees must be empowered and traditional power struggles must be resolved. Changing the culture of the organization to make information a corporate asset requires changing fundamental needs and values of individuals in the organization. It requires changing mental models.

Mental models are complex, deeply ingrained beliefs and expectations about how the world works. Regardless of the theories espoused, mental models are the true determinants of action (Senge, 1994, p. 175). One of the most deeply engrained components of both individual and organizational mental models is the perception of power and control. Information is power; it has been since the beginning of time. Sharing or withholding information is one of the main methods people use to maintain status in the eyes of others. Mental models involving power and control are some of the most difficult to change, because managers themselves are often afraid of losing their power as they empower their employees.

The success of an intranet tool for information sharing is dependent on changing the power base of information, changing the way information is valued in the organization, and changing mental models. Implementing a successful intranet will cause employees at FNMOC to experience the classic symptoms of change including the loss of turf, loss of structure, and loss of control (Bridges, 1993, p.40). These are symptoms they are already experiencing due to the organizational realignment.

5. Cost of Not Changing

Internet technology has become an industry standard and intranets are a logical way to implement the technology at a local level. As more organizations leverage this technology, the expectation of just in time, up-to-date information becomes prominent. With Dr. Langston's vision of a Navy intranet, FNMOC will eventually be required to have an intranet. With Admiral Clemins' IT-21 initiative, the tools for easy HTML documentation and publication will exist in nearly all applications. FNMOC currently has the technology and is currently in the "neutral zone" with the realignment. If FNMOC does not leverage this technology and embrace this change now, they risk the redevelopment of old mental models, duplication of effort, and power struggles over information.

V. RECOMMENDATIONS

A. IMPLEMENT A LEVEL ONE INTRANET

The FNMOC intranet that exists today is the result of technologically proficient individuals attempting to use current technology to improve the means of communicating within and between departments. It consists of a number of departmental web pages that outline the functions of the departments and the projects they are working on. Employees at FNMOC have created web pages for internal organizational use. These web pages have not been formally implemented for command-wide use and in some cases have not been kept up-to-date. The intranet began as a grass-roots effort to create an information repository and ended because of a lack of understanding of the technological requirements of an intranet.

The authors recommend that FNMOC take advantage of the initiative put forth by its employees and implement a level one intranet. This intranet would provide departments and divisions with a means of cross-platform communication and an easy-to-use information repository. The initial use of the intranet would be primarily administrative, allowing for project coordination, quality assurance, and general access to information. It could also serve as a developmental and testing vehicle for prototypes and products destined for the Internet. This intranet should be implemented throughout the

unclassified portion of the network and could eventually be expanded to service FNMOC Detachments in Oklahoma and North Carolina.

Successful intranet implementation is dependant on a number of factors. The most important of these is a well thought out plan of implementation and an infrastructure that puts web page development and maintenance responsibilities at the lowest possible level. This chapter describes a recommended process for intranet implementation at FNMOC.

B. CREATE A SYSTEM TO KEEP THE PHYSICAL NETWORK TOPOLOGY REFERENCES CURRENT

FNMOC has an extremely large computer network that serves as a vital component of the organization's infrastructure. The computer network could easily be classified as a Campus Area Network rather than a Local Area Network. This robust network is in a continuous state of change and upgrade. During the authors' early research, it was difficult to identify any single individual or group that had a complete understanding of the network's physical layout. The loss of a few key individuals could leave FNMOC without a complete understanding of the details, history of, and plans for the physical network layout. FNMOC must enforce closer management of hardware resources in an effort to ease problems of connectivity and inter-operability. The authors recommend investing in a detailed configuration management program.

C. COMPLETE OPERATING SYSTEM UPGRADE

In order to fully implement an organization-wide intranet, the operating system upgrade must be completed. Until the appropriate software is installed, all users will not be able to access an intranet. This upgrade is currently in progress.

The installation and use of web browsing software increases the capabilities of the user beyond the basic intranet. Web browsers not only allow internal access to the intranet; they enable employees to access the Internet as well. During employee interviews, it was evident that Internet access is becoming one of the tools required by FNMOC employees to keep up with advances in technology, current trends in the industry, and professional competencies. One interviewee expressed the importance of Internet access in this way: "We are being dragged by our customers to Internet access for product information. The Internet makes it easier to find out what is going on out there."

The software installation required to install a level one intranet includes web servers and web browsers. Web server software, specifically Novell Web Server, requires approximately four person-hours to set up and test. Netscape's web browser software requires approximately ten-minutes to install and set up per client. (Gareau, 1997) With the planned upgrade to Windows95 operating systems, a web browser (Internet Explorer) comes already installed.

The process of computer hardware and software installation is the responsibility of the Computer Systems department. Current plans for system upgrades include 213

Intel 80486 computers with Windows95 and 100 Pentium computers with WindowsNT operating systems. In addition, four web servers are planned and will be distributed to localize heavy network traffic within the departments. In general, the Computer Systems department has ambitious plans and time-lines for installation and upgrades, which are often not met due to resource constraints. Although installations and upgrades for the hardware and software necessary to implement are already planned, the installation process must be well organized and realistically timed.

D. IDENTIFY RESOURCE CONTSTRAINTS AND MIGRATION PATHS

Other than internal reorganization, the environment at FNMOC is not expected to change very much. As one of the two master computer centers for the Navy Meteorology and Oceanography Command, it is not likely that FNMOC will be identified for base closure. It is also not likely that they will receive any significant increase in available resources. The following resource constraints were extracted during interviews with the Executive Officer, Technical Director, and Chief Information Officer. These constraints were used as a baseline to determine the feasibility of intranet implementation.

- No additional personnel will be hired to maintain an intranet
- No/limited additional funding for intranet-specific software
- No/limited additional funding for intranet-specific hardware
- Must not interfere with the primary mission of employees
- An existing technological communication system must be replaced
- Platform independence
- DMS compatible
- IT-21 consideration

Although the identified resource constraints limit the amount of funding for hardware and software for an intranet, planned system upgrades already account for nearly all necessary hardware and software expenditures. The technological capability of intranet already exists in the industry and at FNMOC. The technology used for an intranet is the same as that used for the Internet. The only difference is that the intranet exists behind the organizational firewall. Hardware and software expenditures for implementing an intranet are minimal because upgrades in progress at FNMOC account for nearly all of the economic output required.

In terms of personnel, FNMOC already possesses much of the skill set required to operate a level one intranet. Ninety-four percent of survey respondents indicated some experience using web browsers, with 75 percent indicating above average abilities. Fifty-nine percent have experience with using HTML and 30 percent have already published HTML documents. Even with this high level of expertise, personnel requirements are of the greatest concern. With this in mind, the authors developed three possible migration paths and selected the most feasible for the installation of an intranet at FNMOC.

1. Migration Path 1

The first possible migration path is to create a department or division of employees who have Internet/intranet experience. This could be done as an additional department or by combining them into the Communications/Technology Integration Department. Within that department would be a centralized project team with the

responsibility of developing plans, policies, creating, and installing the intranet. After installation, this division would also be responsible for centralized web page management and control.

This migration path would require dedicated personnel resources. Given the resource constraint that an intranet must not interfere with the primary mission of employees, a dedicated intranet division is not a feasible solution.

2. Migration Path 2

According to a FNMOC instruction, network management is currently the responsibility of the LAN/Microcomputer Management Division, which is part of the Operations Department. They are responsible for the acquisition, management, maintenance, and use of all microcomputers in the organization. This division is also responsible for conducting electronic and physical software audits of organization microcomputers. Before this division places any new product orders, a request for the product must be brought to the Microcomputer Project Integration Team (MPIT). The MPIT is composed of representatives from each department and is responsible for providing command requirements and allocations for microcomputers. Since the LAN/Microcomputer Management Division is already responsible for the network and the MPIT represents the needs of the FNMOC departments, intranet implementation and maintenance could be assigned to this division and the MPIT. (FLENUMMETOCCENINST 5230.8D)

With the current staffing level in the LAN/Microcomputer Management Division, it is unlikely that they could handle the additional responsibilities of intranet implementation and maintenance. This division must focus its limited resources on completing the operating system upgrade and maintaining the network system.

3. Migration Path 3

The third migration path consists of identifying an intranet champion to take charge of the project and create an intranet team to plan and implement the intranet. This team would consist of individuals from every department, working together to create a cross-platform means of open communication throughout the organization. Once implemented, each department would identify an intranet web baron, who would be the department's representative to the intranet team, create document links for the department, and maintain the department's web page. An organizational intranet web master would be responsible to coordinate a team for policy and planning purposes, oversee the organizational intranet, and solve problems beyond the ability of the web barons.

Migration Path 3, is the most probable path for the implementation of an intranet. It assumes a stable environment and meets the resource constraints of no additional hiring, and no additional software or hardware funding. In addition, if the employees who are developing the intranet are the individuals who are already excited about it and

represent all areas of the organization, it is likely that the work can be dispersed and primary missions will not be affected.

Using migration path three, full intranet implementation at FNMOC is technologically and economically feasible. Culturally, an intranet may be the impetus needed to break some old mental models regarding information and technology. Mental models are complex, deeply ingrained beliefs and expectations about how the world works. Regardless of the theories espoused, mental models are the true determinants of action (Senge, 1994, p. 175). One of the most deeply engrained components of both individual and organizational mental models is the perception of power and control. The success of intranet strategies is dependent on changing the power base of information, making information an organizational asset rather than departmental or personal property (Hoffman, 1994). In addition, many FNMOC employees are dissatisfied with the lack of challenge that exists in their jobs while others feel they are overworked (Knopp, 1997). An intranet would challenge employees to expand their skill sets and sharing information could result in a greater sharing of the workload.

E. ESTABLISH AN INTRANET DEVELOPMENT TEAM

Intranet development should be lead by the newly combined Computer Systems and Communications/Technology Integration Department, department 200. The intranet development team is responsible for creating a vision for the FNMOC intranet, developing policies and procedures, and creating a plan for intranet implementation and

maintenance. This team should consist of five to seven individuals, some whom were involved with the original intranet effort.

Team membership should capitalize on existing interest, enthusiasm, and skill sets. This team should be lead by an intranet champion, who is dedicated to seeing intranet technology utilized to the benefit of the organization. The most logical individual to assume this position at FNMOC is the current Internet/intranet coordinator, Lieutenant Todd Rich. This team should also include the individual who will be assigned the responsibilities of the organizational intranet web master. In an organization the size of FNMOC, it is feasible for the Internet web master to fulfill both roles.

F. CREATE AN INTRANET VISION

The purpose of an intranet vision is to guide the intranet team and the organization during the implementation and development of the intranet. The vision expresses the extent of intranet implementation and use. It is a benchmark to use in assessing intranet progress. The first responsibility of the intranet development team is to create this vision for the organization.

During interviews employees were asked about their vision for an intranet. The authors received an abundance of ideas and suggestions about what an intranet could do the FNMOC. The authors created the following vision of an FNMOC intranet from those interviews. A FNMOC intranet:

- provides FNMOC employees with a fast, usable method of communication across organizational boundaries, for the purpose of information sharing and education
- promotes open communication and idea sharing throughout FNMOC
- provides rapid cross-platform information dissemination
- develops a FNMOC sense of community, with a rich corporate knowledge base
- reduces information duplication
- increases employee skill set, concurrent with evolving technology
- prepares FNMOC for the implementation of a Navy-wide intranet

G. ESTABLISH INTRANET POLICIES AND PROCEDURES

In order to provide a functional framework, the intranet development team must develop appropriate policies and procedures for the FNMOC intranet and its use. The authors suggest the following policy as a basis for FNMOC policy development.

1. Introduction

Intranet policies and procedures are generally very similar to policies already established for the use of telephones, electronic mail, and the internet. This policy is intended to provide basic guidelines for the intranet and is not intended to stifle innovation and creativity. This intranet policy is based on guidelines from Corporate Intranet Development (Griswold, 1997).

a. Purpose

The intranet is a tool that is constantly changing and evolving. The purpose of this policy is to provide intranet users with standard guidelines and information about the intranet.

b. Scope

Anyone who uses the FNMOC intranet must comply with this guide. Currently, intranet usage is limited to the unclassified portion of the FNMOC LAN.

c. Background

Intranets are becoming the communication tool of choice in many organizations. They provide easy cross-platform access to information across traditional organizational boundaries. The Department of the Navy and the Department of Defense are in the process of developing intranets organization-wide.

2. Organizational Structure

a. Intranet Development Team

The intranet development team is responsible for setting the direction of the intranet, establishing policies and guidelines, implementing the intranet, and encouraging employees to become proficient in intranet usage. The intranet team consists of volunteers from all areas of the organization, including programmers,

designers, webmasters, communicators, web publishers, web architects, technical support personnel, and trainers. The team leader will be the intranet champion, and will facilitate weekly meetings of the intranet team, to ensure focus, direction, and rapid development.

b. Intranet Maintenance Team

After the intranet has been implemented throughout the organization, an intranet maintenance team will be established. A core group of web experts will be identified, as well as an intranet webmaster and departmental web barons. The experts will continue to expand intranet capabilities and application development. The webmaster will be responsible for the overall monitoring and maintenance of the FNMOC intranet and be the key point of contact for all intranet-related issues. The departmental web barons will be responsible for departmental web page development, content, and maintenance. The intranet webmaster, along with the departmental web barons, will be responsible for creating and modifying intranet policies and guidelines, evaluating intranet usage and performance, and act as a clearinghouse for all intranet related issues and ideas.

c. Hardware/Software Acquisition and Maintenance

Microcomputer and LAN hardware and software maintenance is the responsibility of the LAN/Microcomputer Management Division (Code 53). Any hardware or software problems should be reported to Code 53 via electronic mail or telephone. Include name, location, telephone number, and a description of the problem.

New product acquisition requests should be directed to the departmental MIPT representative for evaluation and processing.

3. Security/Monitoring

Security is the responsibility of all FNMOC employees. All users must ensure that information is not compromised or altered during intranet usage. The intranet is for official use only. The intranet webmaster will conduct periodic web page audits to assure compliance with organizational intranet policies and standards.

4. Intranet Use

The FNMOC intranet is for official government business. All web publications shall be related to the performance of the FNMOC mission. The intranet shall be considered a business tool, which is not to be used for non-business or personal material. Personal professional web pages may be created at the discretion of each department and must comply with all intranet policies and standards. The creation of personal web pages is encouraged for the purpose of increasing intranet proficiency and organizational information sharing.

5. Web Page Publication

Every department shall construct and maintain a web site, complete with information that describes the department's mission and responsibilities, organizational

structure, and primary points of contact. Divisional and personal web pages will be linked to the departmental site. The departmental web baron is responsible for ensuring that all departmental, divisional, and personal web page design and content comply with FNMOC policies and standards. Links between departments to avoid duplication of information is encouraged. Web page content is the responsibility of the department. It must be kept up-to-date and it must *look* like it has been kept up-to-date (Guengerich et al., 1997).

6. Training

The intranet development team will establish intranet training requirements and guidelines. Intranet training will occur on three levels: 1) basic, 2) intermediate, and 3) advanced. Basic intranet training will focus on basic user requirements: browser familiarity and web page navigation. All FNMOC employees are required to obtain basic user proficiency. Intermediate training will focus on web publishing: basic HTML, saving documents as HTML, and document conversion to HTML. Advanced training will focus on creating and managing document links and departmental web pages, CGI scripts and Image maps. Advanced training will be required of all departmental web barons.

H. DESIGN THE INTRANET STRUCTURE

The intranet development team is responsible for developing the overall intranet structure. This structure will be the basic structure of how web pages are developed, connected, and maintained. This structure will determine how easy it is to navigate the intranet and link documents. The intranet structure should reflect the structure, mission, and processes of the organization.

The first step to creating an easy-to-navigate intranet is the storyboard process. This process involves brainstorming intranet ideas and applying them to the intranet vision to determine what information should be available to users and how it should be presented. These ideas should then be logically grouped together to develop main topic areas for intranet home pages. Grouping information together to create home page categories simplifies intranet navigation. (Griswold, 1997, pp. 44-52)

Using the storyboard process and interview information, the authors created the following structure for the FNMOC intranet.

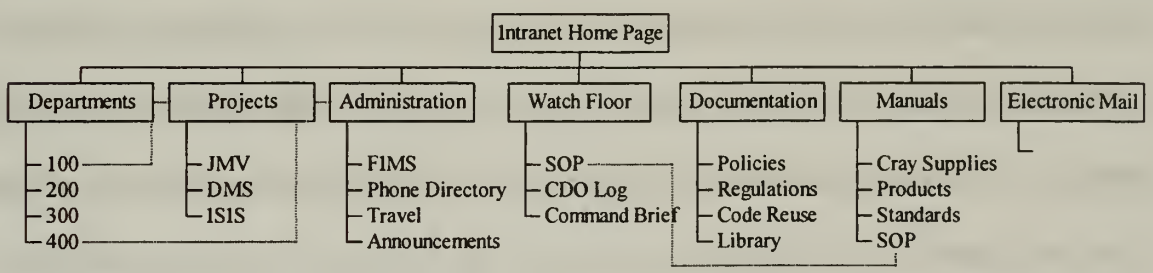


Figure 5-1 Proposed FNMOC Intranet Structure

All intranet navigation begins at FNMOC's intranet home page. This page is basically a navigation page that links to all of the other main topic pages. In addition, it contains mission and vision statements, a link to the organizational structure, a help file for new users, a search engine or indexing tool, and a place for command-wide announcements.

The next level of navigation is the main FNMOC topic pages. This level includes pages that link to departments, projects, administration, watch floor, documents, manuals, and electronic mail. These pages provide a link between the main home page and lower level pages. These pages must provide a brief description of the pages they are linked to. For instance, the pages that link the main page to the department pages and project pages would contain department/project names, missions, and points of contact. It is important that complete page descriptions are maintained to make navigation easy.

I. DESIGN FNMOC WEB PAGE STANDARDS

It is recommended that the intranet development team design web page standards. These standards ensure that all intranet home pages have the same basic layout, which enables the user to find information and navigate more easily. As a minimum, each page should contain the page title, contact information about the person maintains it, the date of the last update, and a navigation bar that takes the user back to the main topic pages. All of these basic items should appear in the same location on all pages. Consistent use of navigation tools makes the system easier to use.

Page design must also be considered. A good visual page layout allows users to find the information they are looking for quickly and easily. Consider background and text color, the amount of white space, and graphics. Backgrounds should be light in color, with dark text. Because graphics increase the time it takes a page to load, the value of an image must be considered before it is used. Pages should take no longer than two or three seconds to load. Pages should be uncluttered, easy to scan, and easy to read.

Other design considerations for making the internet easy to navigate and user-friendly include the following (Bernard, 1996, pp. 110-119):

- Minimize the number of clicks it takes to reach information so that users can reach the information quickly and easily.
- Include a system to quickly identify new and recently updated material.
- Provide a master table of contents or index.
- Make printing easy.
- Ask users for feedback and use it.

J. ESTABLISH A TRAINING PLAN/PROGRAM

Training is required for FNMOC employees to use an intranet. As with any new system, employees must be trained to operate it and be trained in the proper policies and procedures surrounding its use. The results of a survey conducted at FNMOC indicate that 94 percent the respondents have experience using web browsers and 59 percent have experience publishing in HTML. Considering the technical and computer-based nature of the organization and the worldwide growth of the Internet in homes and schools, it is possible that the survey respondents illustrate the overall expertise of FNMOC employees. If this is true, only six percent of the employees need complete web training.

Even if this is not true, it does show that approximately one-third of the employees at FNMOC will not need complete web training.

For employees who have no web browsing experience, it is estimated that a four-hour course would be sufficient to familiarize them with web browsing skills and the organizational policies regarding the intranet. After that, the best training is hands-on use and exploration. For individuals with web browsing experience, the required training would consist only of policies and procedures, which could be done via the intranet, resulting in no loss of productivity.

New employees are currently required to attend a four-hour course for electronic mail and bulletin board training, regardless of experience. For new employees with no web browsing experience, this training could be conducted on the same day. As the intranet replaces bulletin boards, bulletin board training would be phased out. A four-hour intranet course should be structured in three sections. The first section is basic intranet structure, policies, and procedures for FNMOC. This section is required of all employees regardless of web experience. The second section is basic web browser use and navigation and is only required for those without previous web experience. The third section is publishing web pages and documents, possibly incorporating basic HTML training. This training is also optional for those with previous web publishing experience. Some employees will feel that they do not require this section of the training because they will not be publishing. It is recommended that it be required to build employee skill sets and give a deeper understanding of the technology and its possibilities.

This training should be developed through the intranet development team, in conjunction with the training division. Currently, the FNMOC training division is held in low esteem; time require for training is considered time lost for productivity. Yet, the training division is an important element of any organization. In many cases, time spend struggling to learn a task or skill accounts for more lost productivity than four hours of training. Properly training users for intranet use, policies, and procedures should be the responsibility of the FNMOC training division, a division that is eager to teach and employ web technology.

K. ESTABLISH AN INTRANET MAINTENANCE TEAM

In general, intranets require low maintenance and upkeep. During FNMOC's "grass roots" intranet implementation, the web master spent four hours per week, or less, administering the intranet. Spreading this workload over several web masters or web barons would significantly reduce the effort required by any specific individual. For example, the Silicon Graphics intranet consists of 2,500 web servers with more than 200,000 pages of information and is serviced by three intranet web masters who spend approximately five minutes per day administering their intranet.

Four intranet management areas that must be considered are strategic development, network administration, web page management, and web application development. The authors recommend a management structure of three basic areas: strategic development, infrastructure management, and web application development.

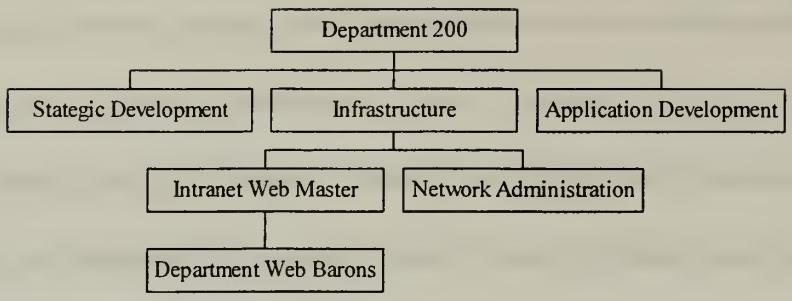


Figure 5-2. Intranet Maintenance Structure

Strategic development is an offshoot of the intranet development team and is a group of forward-looking individuals who plan for future web growth and development. Web application development is performed by the technologists, who develop the applications and programs needed to grow beyond a level one intranet. Infrastructure management is the most critical of the three areas. This section is responsible for both the network administration and on-going web page development and management. Network administration is the easy part and is already handled by the Computer Systems Department. Web page development and management is the most critical aspect of intranet management. It can determine the success or failure of the FNMOC intranet. This component of infrastructure management involves the creation and management of all of the web pages and electronic documents in the organization.

In order to implement a long-standing and successful intranet, web page development and management must be distributed to the department/division level. Distributed web page development and management reduces the time required to create and publish web pages. Reaching an agreement and implementing any centralized project often takes longer than training employees to do it themselves. In the time it would take

to generate one web page centrally, each department could have created its own page independently. (Telleen, 1996)

As a minimum, the intranet structure for an organization should include a web page for the organization and a web page for each department. Because of the amount of information that exists in most organizations, it is also common for each division to have a web page. Some organizations even allow a web page for each employee. Depending on the size of the organization, this can add up to more pages than any one individual can effectively develop and manage.

In order to gain user support and serve the information needs of the organization, intranets must be developed and implemented rapidly. Since authoring web pages and HTML documents is not difficult, employees will become frustrated if they have to wait for a central project team to develop their pages for them. Establishing policies and procedures to allow distributed web page development and management allows employees to quickly gain access to and disseminate organizational information.

Distributed web page development and management assures that web page content is useful, accurate, and up-to-date. Web page content management and control should be distributed to the lowest level because that is where the knowledge and the need exist. Each department and/or division has unique information needs and knows its responsibilities and tasks better than anyone else. What is important for employees in one area of the organization may not be important in another. Therefore, each department

and/or division should be responsible for the development and management of its own web page(s). (Griswold, 1997, pp. 22-24)

When web page content is in the hands of the stakeholder it is more likely to be kept current and accurate. Because web pages are constantly evolving and changing, links to other pages and documents must be periodically checked for continuity. Unless someone who cares about a page is responsible for maintaining it, it will quickly become useless and obsolete. Distributed management allows each department and/or division to get the web page look and feel it desires, and because it is in their best interest to make it useful and valuable, they are more likely to keep it up.

Modern system theorists agree that employees who feel they are making valuable contributions to the organization are more productive. According to Socio-Technical System Design principles, people work better when they have the opportunity to meet personal needs through their work. People need feedback, recognition, and movement toward a better future. In addition, organizations work better when policies do not restrict employee involvement in innovation or problem solving. (Pasmore, 1989, pp. 42-43)

In many cases, the information sharing nature of intranets causes organizations that use traditional management structures to reevaluate management practices and move toward empowering employees. Because of this, distributed web page development and management enables high-performance, high-commitment work cultures. The five elements of these cultures include delegation, teamwork across boundaries, empowering

employees, integrating people with technology, and sharing a sense of purpose (Sherwood, 1988).

Distributed management of web pages delegates the responsibility for content and management to the lowest level. This not only creates more useful pages; it empowers employees to take control of defining what they need to do their job effectively. The intranet itself encourages teamwork and information sharing across boundaries, creating links and relationships between departments and/or divisions. Distributed management also connects employees with technology and encourages the development of new skill sets. Finally, migrating to an organizational intranet can create a common knowledge base throughout the organization and instill a feeling of common purpose and effort.

Intranets are simple communication tools that encourage the development of distributed management systems. The successful implementation of an intranet at FNMOC requires planning and change. Ultimately, one of the goals of the intranet is to provide a communication system that influences behavior in a positive way. The implementation of intranets can result in a general movement toward distributed management systems, as stated in *Building the Corporate Intranet* (Guengerich et al., 1997, p. 344):

> In fact, putting an intranet into production can be a catalyst for developing a distributed systems management framework where one doesn't exist or is inadequate.

Theoretically, the distributed development and management of web pages could ultimately lead to chaos. With the abundance of information available in any

organization, there must be some means of control. For FNMOC, this method of controlling the intranet can be done by creating an indexing tool or directory that automatically connects users to the information they need. This tool can be created using HTML even after web pages have been created. Thus, the ability to search for information gives the appearance of centralized intranet control on top of a distributed web page development system. (Bernard, 1997, pp. 318-324)

Distributed web page development and management reduces the time it takes to create and publish organizational web pages, assures valuable and current web page content, empowers employees, and creates a high performance work culture. In order to capitalize on intranet success, FNMOC must rethink the way they view information. Distributing web page responsibilities is the first step to creating a culture where information is a corporate asset. As Ryan Bernard states in *The Corporate Intranet* (1996, p. 316):

> Web systems work best when people are given the same freedom to use them that they now have with ordinary business applications like desktop publishing and spreadsheets.

VI. CONCLUSION

A. INTRANET TECHNOLOGY

Intranets use the same technology as Internets. This technology has been tested and proven as an industry standard over the past seven years and is becoming prominent in homes, schools, and libraries around the world. Numerous organizations have discovered that adopting this technology for use within the confines of the organization improves organizational communication and employee productivity. As such, intranets are expected to continue to proliferate in commercial organizations.

In addition to being comprised of industry standard technology, intranets are easy to use. Web browsing software is easy to learn and understand. This is especially evident by the number of children who use this technology at home and in school. The language of the intranet, HTML, is a simple language used for building web pages and electronic documents. With many of the most current software programs, HTML documents can be created automatically, without the user knowing any code at all.

The basic intent of an intranet is information sharing. Organizational information takes many forms. In order to match types of information with intranet implementation and make intranets scalable for each organization three levels of intranet implementation have been identified. The first level is static publishing. At this level, information repositories are available to the user at the click of a button. Some of the information that

is available on a level one intranet are policies, procedures, documents, manuals, and phone directories. Level two intranets are developed around the processes of the organization. Level two intranets retain all of the functionality of level one intranets and adds things like interactive databases and workgroup computing. Level three intranets add advanced applications such as real-time, interactive process execution and monitoring.

B. FNMOC INTRANET

Based on this research, the authors have determined that FNMOC should implement a level one intranet immediately. Hardware and software costs are minimal, employee interest and enthusiasm is high, and the organization is currently in a transition which is designed to improve communication across organizational boundaries. Level two and three application implementation is recommended for the future, as it pertains to the fulfillment of the organizational mission.

The business processes at FNMOC require a high level of interactivity. Departments and divisions are highly dependent on one another and project groups are designed independent of organizational boundaries. Some of the current communication problems and duplication of effort can be alleviated by making information available to all employees through a level one intranet and encouraging cross talk and interaction between groups. Some of the communication problems are not technologically related and must be addressed managerially.

The act of planning and implementing an intranet can be the impetus to move information ownership from the individual to the organization. Sharing information gives employees to have a better understanding of how the organization fulfills its mission and where they fit in that process. Employees at FNMOC are ready to adopt intranet technology and feel that it will help them do their jobs better. Training users for the intranet requires the same amount of training as the current electronic mail training program (or less). Approximately one-third of FNMOC employees already have web browsing and publishing skills and would only require training in policies and procedures regarding the intranet.

C. NAVY INTRANET

The ability to implement intranet technology at the military command level is a prerequisite for making the vision of the Chief Information Officer of the Department of the Navy possible. This vision for future technology integration in the Navy includes a Navy-wide intranet. Like the Internet, this intranet is a network that connects many smaller networks, which are created at the command level.

Although FNMOC is unique because of the number of civilians employed there, FNMOC displays many of the classic problems of a military organization: high turnover of military personnel, lack of communication, and duplication of effort. The success of command level intranet implementation such as that recommended for FNMOC will determine the future success of a Navy wide intranet.

D. FUTURE STUDIES

As FNMOC and the Navy migrate toward intranet implementation for improved communication and interoperability, it is recommended that additional studies be conducted to advance applications beyond level one intranets. Sharing static information is only one component of organizational information sharing. The business processes themselves must also be integrated in order to reach the full potential of the intranet.

Further study is also required in order to move beyond intranets that exists within physical organizational boundaries and toward extranets that connect organizations that are physically distributed. For FNMOC, this includes connection to detachments in Oklahoma and North Carolina. For the Department of the Navy, this includes the entire Navy intranet infrastructure. The idea of using extranets to connect remote sites must be thoroughly investigated for feasibility and security. Some means of protecting proprietary information must be utilized.

APPENDIX A. IT-21 STANDARDS

This following lists the IT-21 statndards as promulgaed by the Commander in Chief, U.S. Pacific Fleet, in CINCPACFLT Naval Message, ALPCAFLT 008, 300944Z MAR 97.

A. IT-21 LAN:
   (1) Afloat LAN standards - ATM fiber backbone, 100 mbps (fast ethernet) to the PC.
   (2) Ashore tactical and headquarters command center standard – ATM backbone, 100 mbps (fast ethernet) to the PC.
   (3) Ashore tactical support command standards (bases) – ATM BACKBONE, 100 mbps (fast ethernet) to the PC.
   (4) Metropolitan Area Networks (MAN) should be capable of supporting at least OC-3 (155MBS).

B. IT-21 Software:
   (1) Windows NT 4.0/5.0 workstation
   (2) MS OFFICE 97 professional (Word 97, PowerPoint 97, Excel 97, MS Access 97)
   (3) IBM Anti Virus (Navy license, available from NAVCIRT)
   (4) MS Back Office Client
   (5) MS Outlook 97
   (6) MS Exchange 5.0
   (7) MS Image Composer

C. IT-21 Databases. Relational databases that can support web technology in accordance with the COE (Oracle, Sybase, SQL Server, Access, etc.) will be used to support data requirements and application development. All process engineering initiatives that result in design/redesign of a data collection/capture system must use COE compliant relational database management systems (RDBMS) software. This requirement is provided to ensure RDBMS initiatives use COTS application software.

D. Minimum IT-21 PC Capabilities: the IT-21 standard PC can currently purchased with software for $3250 - $3579.
   (1) 200 MHz Pentium Pro CPU
   (2) 64 MB EDO RAM
   (3) 3.0 GB hard drive
   (4) 3.5 inch floppy disk drive
   (5) 8X IDE CD-ROM
   (6) Dual PCMCIA/PC card reader
   (7) PCI video w/2MB RAM

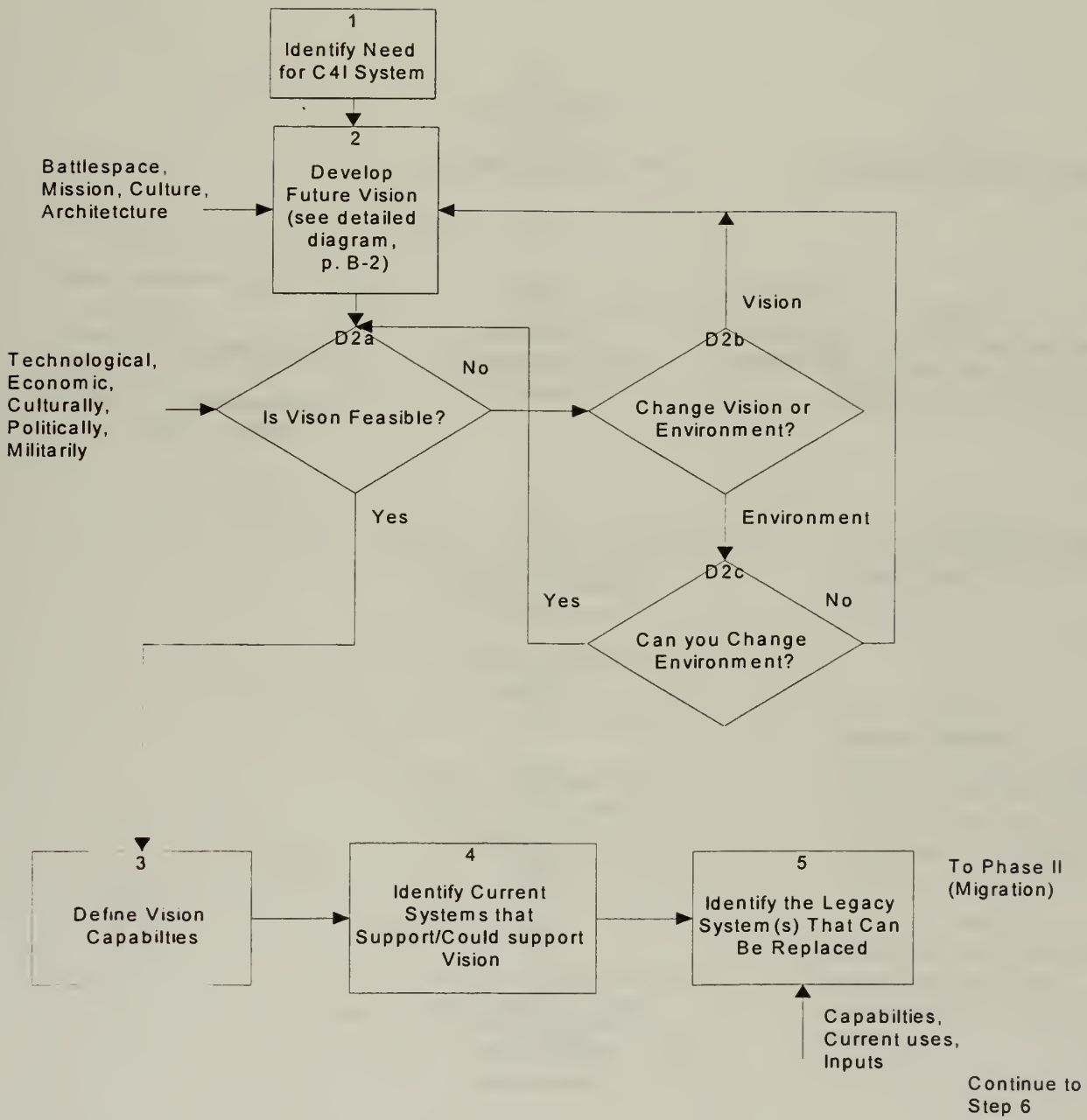
(8) 17 inch monitor (1280X 1024)
(9) Pointing device (trackball or mouse)
(10) Soundblaster (compatible) audio card with speakers keyboard
(11) CPU compatible 100 mbps fast ethernet NIC

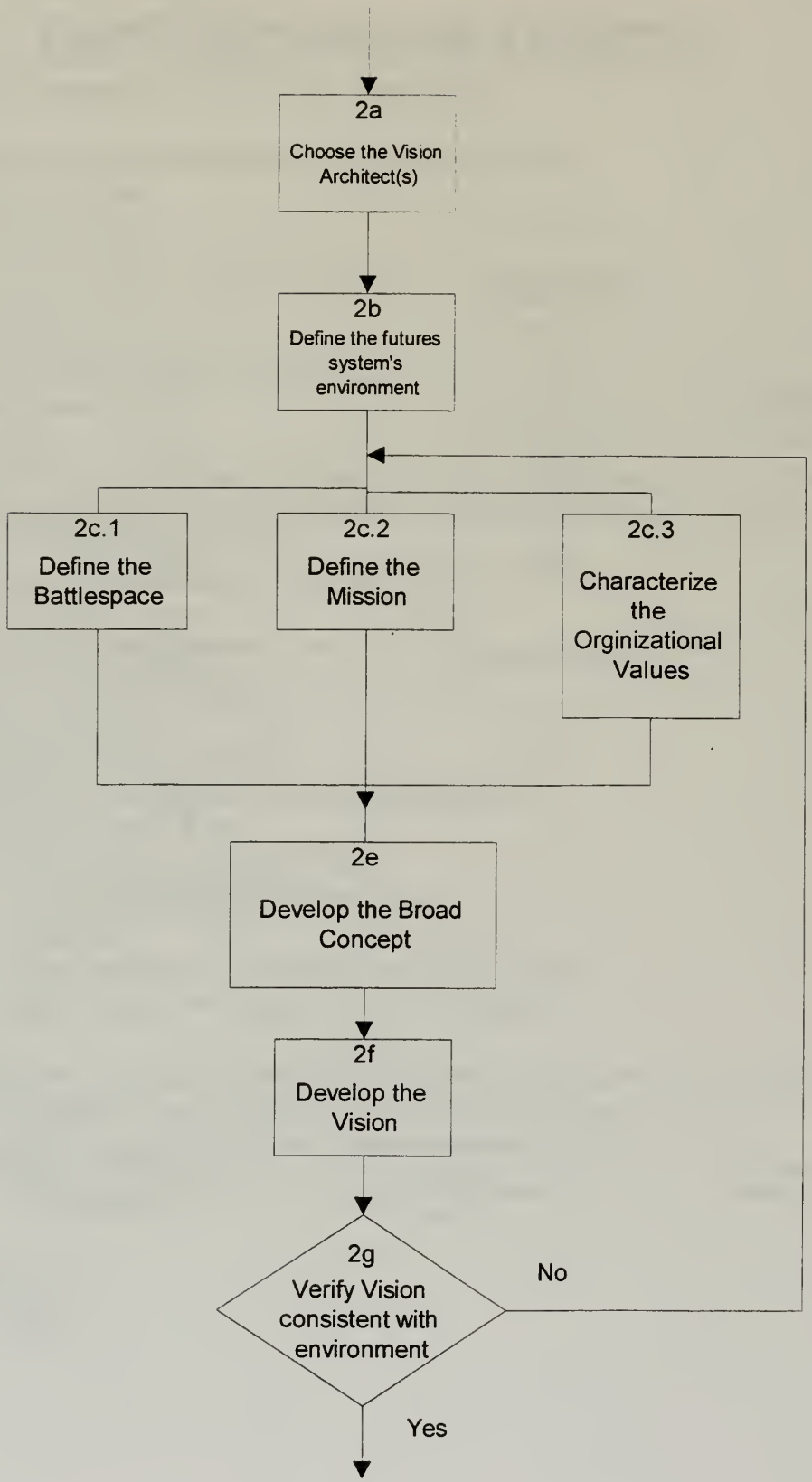
E. Standard IT-21 Laptop Workstation: approximately $5300.
(1) 150 MHz Pentium
(2) 32 MB EDO RAM
(3) 12.1 in SVGA active matrix color display
(4) 2.1 GB EIDE HDD
(5) 6X INTERNAL CD-ROM
(6) Modem, PCMCIA slots, NIC card
(7) Smart lithium battery

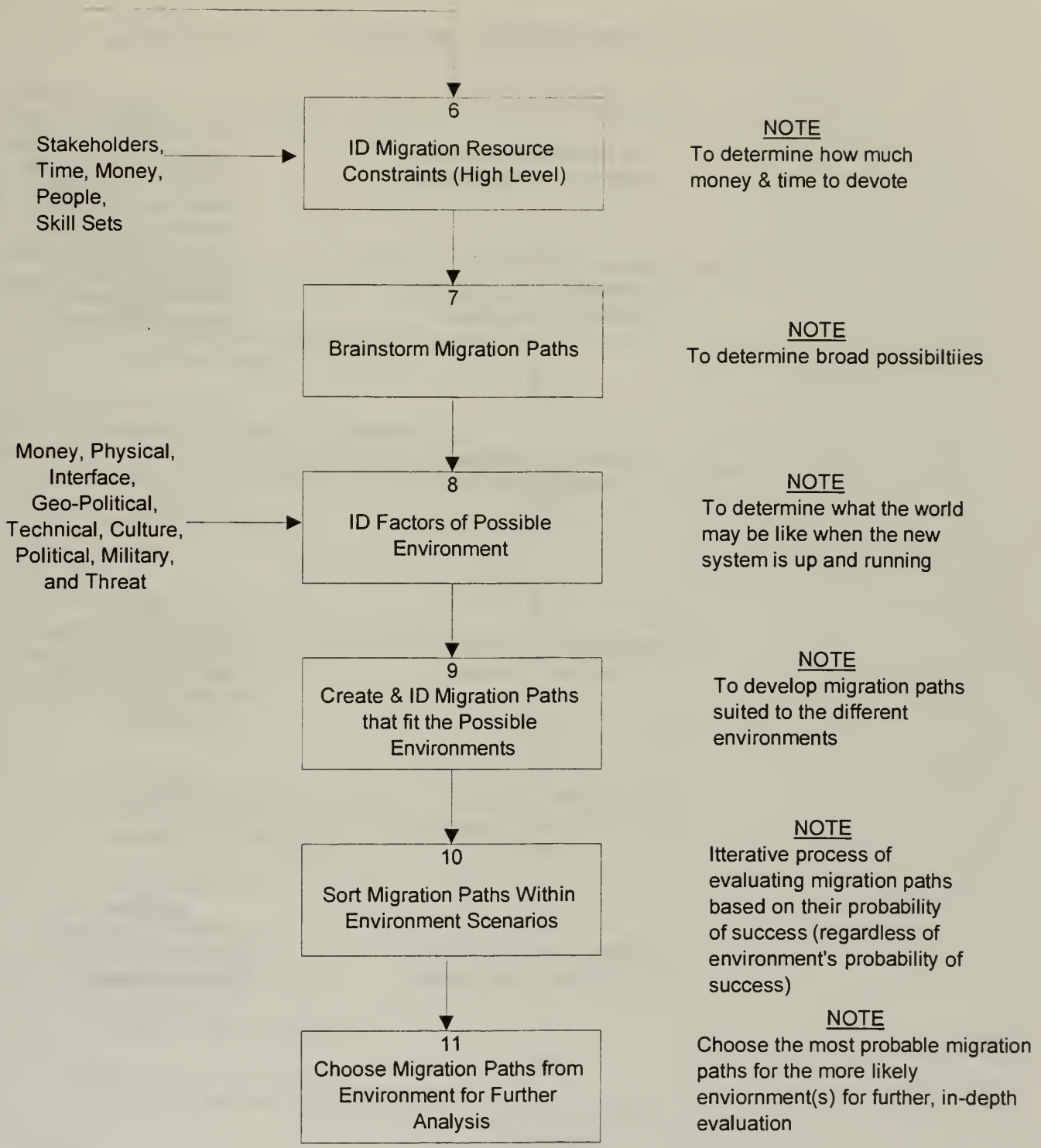
F. IT-21 NT File Server for Directory Network Service: approximately $26K. These are minimum specifications. Needs of the specific network will dictate requirements.
(1) Dual 166 MHz Pentium CPU
(2) 512K secondary cache memory- 256 MB RAM
(3) TWO 4 GB SCSI HDD
(4) ONE 6 GB DAT drive
(5) ONE 3.5 inch floppy disk drive
(6) 6X SCSI CD-ROM
(7) Dual PCMCIA/PC card reader
(8) 2 DPT SCSI III caching controllers (Smartcache 4)
(9) PCI VIDEO W/2MB RAM
(10) 17 inch monitor (1280 X 1024)
(11) Pointing device (trackball or mouse)
(12) Keyboard
(13) Two Cabletron CPU compatible ATM NIC cards
(14) Antec dual power supply case (hot swappable)

G. IT-21 File Server/Application Server: approximately $26K. Same as IT-21 NT file server for directory network service with the following changes:
(1) Change HDD requirement to five 4 GB drives Change DAT to 18 GB.

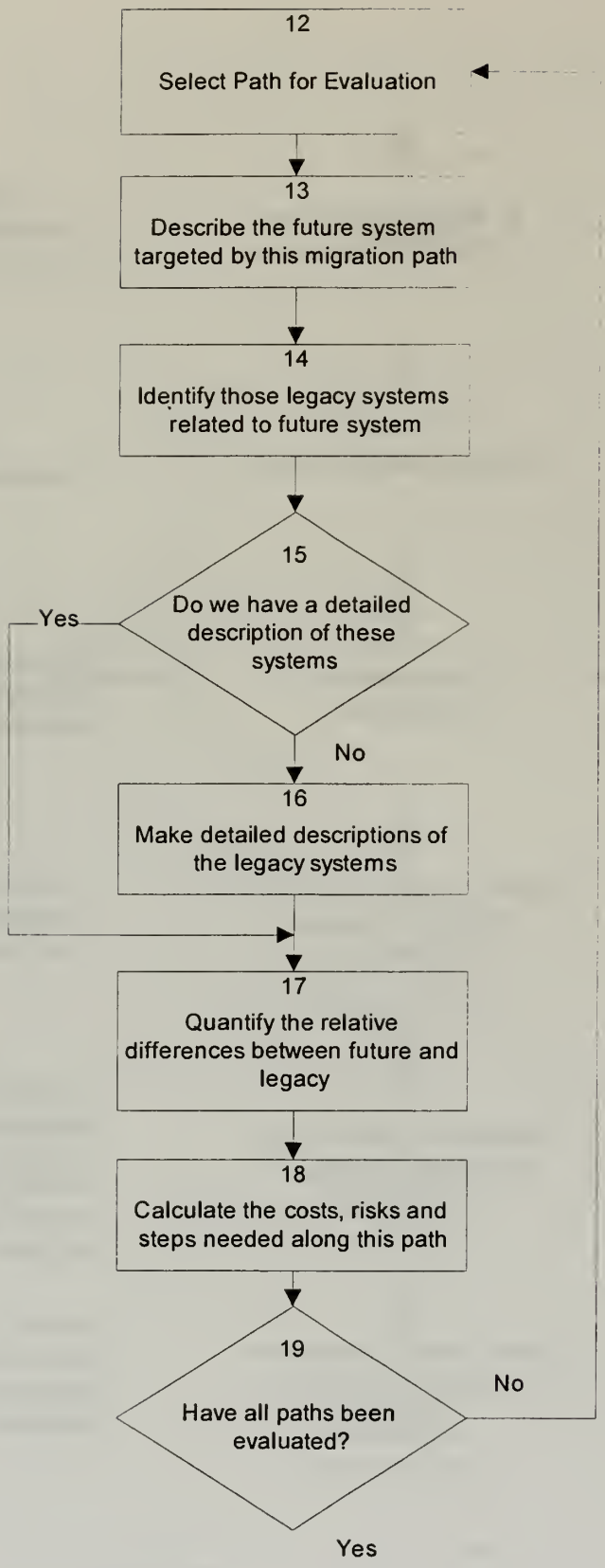
APPENDIX B. HEURISTIC FLOW CHART




2a
Choose the Vision Architect(s)
2b
Define the futures system's environment
2c.1
Define the Battlespace
2c.2
Define the Mission
2c.3
Characterize the Orginizational Values
2e
Develop the Broad Concept
2f
Develop the Vision
2g
Verify Vision consistent with environment
No
Yes


6
ID Migration Resource Constraints (High Level)
Stakeholders, Time, Money, People, Skill Sets
NOTE
To determine how much money & time to devote
7
Brainstorm Migration Paths
NOTE
To determine broad possibiltiies
Money, Physical, Interface, Geo-Political, Technical, Culture, Political, Military, and Threat
8
ID Factors of Possible Environment
NOTE
To determine what the world may be like when the new system is up and running
9
Create & ID Migration Paths that fit the Possible Environments
NOTE
To develop migration paths suited to the different environments
10
Sort Migration Paths Within Environment Scenarios
NOTE
Itterative process of evaluating migration paths based on their probability of success (regardless of environment's probability of success)
11
Choose Migration Paths from Environment for Further Analysis
NOTE
Choose the most probable migration paths for the more likely enviornment(s) for further, in-depth evaluation

continue to step 12



NOTE
This where you do the detailed look at h/w, s/w, w/w. Appropriate to do future sys. vulnerability analysis here. Also look at Expected Measures of Effectiveness (EMOE) and Expected Measures of Performance (EMOP).

NOTE
This where you do the detailed look at h/w, s/w, w/w. Appropriate to do legacy sys. vulnerability analysis here.

NOTE
Look at MOE and MOP.

NOTE
Adjust the future system based on our hard look at the legacy system.

Continue to step 20

APPENDIX C. SYSTEM DESCRIPTION CRITERIA

The following areas need to be considered, to fully define the current legacy system. This description will be used as a baseline comparison for all candidate systems as well as for describing the future vision system.

A. Hardware

1. Processing
   a. type and number (e.g. 3 Cray 7200 supercomputers, 50 Pentium microcomputers, etc.)
   b. processing speed
   c. security
   d. how attached to network architecture
   e. cost of maintenance

2. Network Architecture
   a. number and type (e.g. FDDI, Ethernet, etc.)
   b. throughput capacity (e.g. 100 MBPS)
   c. number and type of satellites, routers, hubs, switches, etc.
   d. attached nodes
   e. cost of maintenance
   f. security

3. Input/Output Devices
   a. number and type
   b. how attached to network architecture
   c. throughput capacity
   d. cost of maintenance
   e. security

4. Storage
   a. number and type
   b. storage capacity, individual and total
   c. associated processors (e.g. hard drive on a Pentium)
   d. how attached to network architecture
   e. cost of maintenance
   f. security

5. Support Hardware
   a. buildings
   b. power sources
   c. physical security mechanisms

6. Current Use
   a. How the current hardware systems used

B. Software

An assessment of the legacy software may be performed by examining the following "quality criteria." Each criterion should be evaluated for each of the software modules that make up the legacy system software (e.g., operating system, database management system, graphics, computational, etc.).

Anomaly Management	Non-disruptive failure recovery
Augmentability	Ease of expansion in functionality and data
Commonality	Use of standards to achieve interpretability
Completeness	All software is necessary and sufficient
Consistency	Use of standards to achieve uniformity
Distributivity	Geographical separation of functions and data
Document Quality	Access to complete understandable information
Efficiency of Communication	Economic use of communication resources
Efficiency of Processing	Economic use of processing resources
Efficiency of Storage	Economic use of storage resources
Functional Scope	Range of applicability of a function
Generality	Range of applicability of a unit
Independence	Degree of de-coupling from support environment
Modularity	Orderliness of design and implementation
Operability	Ease of operating the software
Safety Management	Software design to avoid hazards
Self-descriptiveness	Understandability of design and source code
Simplicity	Straightforward implementation of functions
Support	Functionality supporting the management of changes
System Accessibility	Controlled access to software and data
System Compatibility	Ability of two or more systems to work in harmony
Traceability	Ease of relating code to requirements
Training	Provisions to learn how to use the software
Virtuality	Logical implementation to represent physical components
Visibility	Insight into validity and progress of development

C. People

1. Training
   a. Are people in the organization cross trained to do numerous jobs?
   b. Are formal schools used or is training based on on-the-job training?
   c. What incentives exist to complete training?
   d. Does training include problem solving skills?
   e. How do new people learn their jobs?
   f. How is the quality of the training measured?

2. Skill Level
   a. Does the career path allow people to progress in the organization as they master certain skills?
   b. Is there a continuing education program for employees?
   c. How long does it take to acquire the proper skills to be productive? How long to master the skills?
   d. Is it cost effective to retrain current employees or recruit new ones?

3. Organizational Structure
   a. Is it a hierarchical or flat organization?
   b. Are decisions being made at the top or at lower levels by employees?
   c. Is the organization centrally located or geographically dispersed?
   d. Is there a feedback loop from the organizational to the individual?
   e. Are customer facing employees empowered to make decisions and take responsibility?

f. Who are the leaders?

4. Command and Control (C2) Decision Process
   a. At each level of the organization, what kind of assets are used to support operations and by who?
   b. Which asset is used frequently and which is not? What are their cost effectiveness?
   c. What do we expect our customers to use? Is it easy to do?
   d. What is the C2 decision process?
   e. What information does/will the current/future system provide?
   f. What information does the current/future system not provide?

5. Customer
   a. What is the customer's volume?
   b. What are the limits for satisfying the customers?
   c. What is given to the customer? What more do they want?
   d. How are customers attracted? How are they kept?

6. Culture
   a. Are team or individual work efforts employed?
   b. What is the quality of life for the work force? Is the atmosphere antagonistic or friendly, positive or negative?
   c. Are employees given the opportunity to act on their own and allowed to make decisions and mistakes?
   d. Is creativity fostered in the work place or is there strict adherence to established rules?
   e. Are performance rewards based on teamwork or individual efforts?
   f. Do employees feel that they have job security?
   g. Does the environment reflect a culture of pride or positive self image for the employees?
   h. Is there passion or any show of emotion about the work that the people do?

APPENDIX D. FNMOC NETWORK SURVEY RESULTS

The survey found that the 72 percent of the computers were Intel 80486 computers. Forty-five percent of the computers were configured with the Windows 3.11 operating system. The computers were primarily used for electronic mail and word processing.

TYPE COMPUTER:

APPLE	I386	I486	PENTIUM	OTHER
1	2	26	5	1

OPERATING SYSTEM:

APPLE	DOS	WIN 3.11	WIN 95	WIN NT	UNIX
1	5	16	8	4	1

PURPOSE OF USE:

SERVER	STORAGE	USER	OTHER
0	2	32	1

USAGE:

WEB BRWSER	E-MAIL	WD PRO-CESSING	SPREAD-SHEET	DATA-BASE	GRAPHIC	OTHER
13	23	24	12	16	13	5

APPENDIX E. INTERVIEWEES AND INTERVIEW QUESTIONS

Department	Number of Interviewees
• Front Office (00)	2
• Enterprise Program Office (EPO)	1
• Operations Department (30)	5
• Models Department (40)	5
• Systems Department (50)	8
• Communications and Technology	
• Integration Department (60)	7
• Data Department (70)	6
• Resources Department (100)	8

Interview questions included the following:

- What is your position at FNMOC?
- How does your job relate to FNMOC's primary function?
- How much of your job is conducted online?
- How much of information related to your job is currently available online?
- What additional information, if available online, would help you with your job?

- Are you familiar with FNMOC's current intranet initiative?
- What to you know of the intranet initiative?
- Do you have access to the intranet?
- Do you have access to the Internet?
- Do any other members of your department have access to the intranet or Internet?
- What potential uses do you foresee for an intranet should one be fully implemented?

- Do you use the electronic mail system?
- Do you find it useful?
- Do you use the Electronic Bulletin Board System?
- Do you find it useful?

APPENDIX F. NETWORK/INTRANETWORK SURVEY

This survey is being conducted as part of the ongoing effort to assess the costs and benefits of fully implementing an Intranet on FNMOC's computer network. Your answers will provide valuable insight into the networks' usage/possible usage. We know that your time is valuable, so we would like to thank you in advance for taking the time to respond.

CDR C. W. Booth and LT Barbara J. Gutsch,
Naval Postgraduate School, Monterey, CA

==========

INSTRUCTIONS: Answer this survey by using your mail reader's "reply to sender" option. Type your answer following the appropriate question. For questions that require a choice, type the letter "X".

1. What is your department/division? _____

2. Which best characterizes your employment?

   DoD Civilian (state grade, e.g., GS-11):_____
   Military (state paygrade):_____
   Contractor:_____
   Other:_____

3. Which best describes your work environment (choose one):

   Office:_____
   Desk (not in an office):_____
   Shared work environment (e.g., watch floor):_____

4. How long have you worked at FNMOC? _____

5. How would your characterize your computer expertise?

   Novice:_____
   Routine user:_____
   Experienced user:_____
   Programmer/Developer:_____
   Other Expert:_____

6. In the course of your daily routine, do you:

   Normally use a single computer:_____
   Use multiple computers, same platform (e.g., all UNIX):_____
   Use multiple computers, different platforms (e.g., UNIX and PC):_____

7. What operating system does your primary computer use?

   Windows 95:_____
   Windows NT:_____
   Windows 3.1/3.11:_____
   UNIX:_____
   Macintosh:_____
   Other:_____
   I don't know:_____

8. How often do your check your email?

   At least weekly:_____
   At least daily:_____
   Several times each work day:_____

9. Would you say that the amount of email that you receive is:
   Much too little:_____
   Too little:_____
   Just right:____
   Too much:_____
   Excessive:_____

10. Estimate the number of email messages you receive daily:

    0-25:_____
    26-50:_____
    50-100:_____
    100-150:_____
    150-200:_____
    >200:_____

11. Do you find the bulletin board system (BBS) useful for finding information?

    Yes:_____
    No:_____
    Don't Use the BBS:____

12. What is your familiarity with using web browsers (e.g., Netscape or Microsoft Internet Explorer) to access the Internet, either from home or work (choose one):

    I have not used a web browser before:_____
    I have some experience using a web browser:_____
    I feel comfortable using a web browser:_____
    I have above average web browser experience:_____

13. What is your experience level with Hypertext Markup Language (HTML)(choose one)?

    I am not familiar with HTML:_____
    I have used HTML, but not published with it:_____
    I have/can publish HTML documents with an application tool:_____
    I have/can publish HTML documents using HTML code/tags:_____
    I have/can publish HTML documents containing JAVA, ActiveX, or CGI:_____

14. What is your best estimate of paper usage? For example, if you routinely print 10 pages per day from your computer, photocopy (Xerox™) 25 pages per week (including projects and report), and send out 1000 pages per quarter to Defense Printing Service your answer would be:

    10____ pages per (day) printer,
    25____pages per (week) photocopy, and
    1000____pages per (quarter) Defense Printing Service

    your answer is [delete, leaving day, week, month, quarter as applicable]:

    _____ pages per (day, week) printer
    _____pages per (day, week, month) photocopy, and
    _____pages per (week, month, quarter) Defense Printing Service

15. Estimate the percent reduction in paper printed if your printed information (reports, status memos, etc.) were available on the computer network. Example, using the above numbers, if 30% (3 out of 10 pages) of your printer output, 60% of your photocopies, and 80% of the Defense Printing Service information could be posted as easily accessed information by all that needed it, you would answer :

    Printer reduction: 30_____%
    Photocopy reduction: 60_____%
    Defense Printing Service reduction: 80_____%

    Your answer is?

    Printer reduction: _____%
    Photocopy reduction: _____%
    Defense Printing Service reduction: _____%

Thank you for taking the time to fill out this survey. Your answers will help in our final analysis.

APPENDIX G. PARTIAL LISTING OF THE SURVEY RESULTS

Response by department	Percent of respondents
Front Office (00)	6
Operations Department (30)	30
Models Department (40)	17
Systems Department (50)	10
Communications and Technology Integration Department (60)	19
Data Department (70)	10
Resources Department (100)	9

Employment	Percent of respondents
Government Civilian Employee	57
Military	33
Contractor	9

Work Location	Percent of respondents
Office	83
Shared Work Environment	14
Desk (not office)	3

Average employment duration at FNMOC: 7.2 years, S.D. 6.75 years

Computer Expertise	Percent of respondents
Novice	2
Routine User	21
Expert User	28
Programmer/Developer	37
Other Expert	12

Computer Operating Systems	Percent of respondents
Windows 95	9
Windows NT	9
Windows 3.11	49
Unix	30
Other	3

Electronic Mail Volume	Percent of respondents
Too Little	4
Just Right	60
Too Much	37

Web Browser Use	Percent of respondents
Have not used	6
Some Experience	19
Comfortably use	40
Above average experience	35

HTML Publishing Experience	Percent of respondents
Not familiar	41
Have used but not published	29
Can/have published with software	6
Can/have published native HTML code	13
Can/have published JAVA/ActiveX	11

The survey found that document printing and reproduction costs were insignificant and that any costs saved as a result in reducing this cost was also insignificant.

APPENDIX H. ABBREVIATIONS

ADP	Automated Data Processing
AFIN	Air Force Network
AIS	Automated Information System
ARNET	Army Network
ARPA	Advanced Research Project Agency
ATM	Asynchronous Transfer Mode
AUTODIN	Automatic Digital Network
C2	Command and Control
C4I	Command, Control, Communications, Computers, and Intelligence
C4ISR	Command, Control, Communications, Computers, Surveillance and Reconnaissance
CDO	Command Duty Officer
CERN	European Laboratory for Particle Physics
CGI	Common Gateway Interface
CINCPACFLT	Command in Chief, U.S. Pacific Fleet
CIO	Chief Information Officer
COE	Common Operating Environment
COTS	Commercial Off-The-Shelf
DARPA	Defense Advanced Research Project Agency
DDN	Defense Data Network
DHCP	Dynamic Host Configuration Protocol
DII	Defense Information Infrastructure
DISA	Defense Information Systems Agency
DISN	Defense Information Switching Network
DLANET	Defense Logistics Agency Network
DMS	Defense Messaging System
DoN	Department of the Navy
EDO	Extended Data Out
FDDI	Fiber-Distributed Data Interchange
FNMOC	Fleet Numerical Oceanographic and Meteorology Center
FPI	Functional Process Improvement
FTP	File Transfer Protocol
GNI	Global Network Initiative
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
IDC	International Data Corporation
IP address	Internet Protocol Address
JMV	Joint METOC Viewer
JQR	Job Qualification Requirements
JTA	Joint Technical Architecture
LAN	Local Area Network
MAN	Metropolitan Area Network

MBPS	Megabits Per Second
METOC	meteorological and oceanographic
MPIT	Microcomputer Project Integration Team
NAVAIR	Navy Aviation
NAVNET	Navy Network
NAVWAN	Navy Wide Area Network
NCSA	National Center for Supercomputing Applications
NIPRNET	unclassified but sensitive Internet Protocol Router Network
NOS	Network Operating System
NPS	Naval Postgraduate School
O&MN	Operations and Maintenance, Navy
OASIS	Oceanographic and Atmospheric Support and Information System
POP	Post Office Protocol
POPS	Primary Oceanographic Prediction System
RBA	Revolution in Business Affairs
RDBMS	Relational Data Base Management System
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
SQL	Structured Query Language
SYSCOM	System Command
TAFIM	Technical Architecture for Information Management
TCP/IP	Transport Control Protocol/Internet Protocol
WWW	World Wide Web

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